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Structural Geotechnical Report

Interstate 57 over Gun Creek
FAI Route 57, Section (28-1) B-2
Franklin County, Illinois
PTB 190-035
Replacement Structures 028-0093 and 028-0094

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1.0 Project Description and Proposed Structure Information

1.1 Introduction

This report summarizes the results of a geotechnical investigation performed for the design of replacement dual structures for the existing bridges carrying Interstate 57 over Gun Creek, approximately one mile north of Whittington, Franklin County, Illinois. The purpose of this study was to provide a geotechnical assessment of the planned replacement structures based on subsurface conditions encountered at two borings performed by the Illinois Department of Transportation (IDOT) in 2019, and eight borings performed by IDOT in 1965 for the existing structures. This report describes the exploration procedures used, presents the field and laboratory data, includes an assessment of the subsurface conditions in the area, and provides geotechnical recommendations for construction.

1.2 Project Description

The project consists of the removal and replacement of the existing Interstate 57 bridges over Gun Creek in Franklin County, Illinois. The general site area is shown on the attached Vicinity Map, Figure 1 in Appendix A. The approximate locations of the borings performed for this study, as well as borings performed in 1961 are presented on the Type, Size, and Location Plan (TSL), Figure 2 in Appendix A. The TSL was provided by the structural engineer, Oates Associates, Inc. (Oates).

Gun Creek is oriented roughly east and west beneath the existing I-57 overpass structures and flows in a westerly direction. The existing bridges were built in 1962, each measuring about 163-foot long and 43 feet wide. The superstructures are three-span concrete decks supported on steel beams. The abutments of each existing bridge are founded on steel H-piles. The intermediate supports are founded on footings supported by steel H-piles. It is our understanding that the existing structures will be replaced with new dual structures supported on integral abutments and center piers. Based on the information provided, it appears that staged construction will be required to maintain traffic during construction.

1.3 Proposed Structure Information

The proposed structures will consist of dual two-span bridges, each with an 8-inch concrete deck supported by 33-inch deep W-shape steel beams. Each structure will have a back-to-back abutment length of 153.5 feet and an out-to-out deck width of 67.3 feet. The planned substructure units include integral abutments and center piers supported by steel H-piles. It is our understanding that the roadway profile across the bridges may increase by 4 inches, with little or no grade change for the embankments or end slopes. Based on the information provided, it appears that staged construction will be utilized to maintain traffic during construction.

Factored loading for the bridges provided by Oates is presented in the following table.

Table 1.1
Factored Axial Loads by Foundation Location (kips)

Load Limit State	North Abutment	Pier	East Abutment
Strength I	1,800	3,550	1,800
Service I	1,250	2,600	1,250
Extreme I	1,100	2,300	1,100

2.0 Subsurface Exploration and Laboratory Testing

2.1 Subsurface Exploration

On April 9 and October 3, 2019 IDOT conducted a subsurface exploration near the north and south abutments, consisting of two soil borings, designated as Borings 1-S and 2-S along Interstate I-57. The approximate locations of the borings are indicated on the Type, Size and Location Plan, Figure 2 in Appendix A.

The borings were advanced using hollow-stem auger drilling methods. Samples were obtained at 2.5-foot intervals to a depth of 40 feet and at 5-foot intervals thereafter to boring termination. Split-spoon samples were recovered using a 2-inch outside-diameter sampler, driven by a 140-pound hammer. The split-spoon samples were placed in containers for later testing in the laboratory. Millennia Professional Services (Millennia) understands the District introduces fluids into the augers in lieu of switching to mud rotary methods when granular soils are encountered. The sampling sequence for each boring is summarized on the boring logs in Appendix B.

The underlying bedrock at Boring 1-S was cored for a depth of about 10 feet. The core samples recovered were measured in the field for percent recovery and RQD value. Photographs were taken of the rock core samples and are attached in Appendix B. Unconfined compressive strength test results from the recovered rock core samples are also presented along with the rock core photographs in Appendix B.

Unconfined compression tests were performed on selected split-spoon samples using a Rimac field testing machine. The resulting unconfined compressive strengths are reported on the boring logs.

Millennia has also included the boring log data (Borings 1 through 8) from the 1960’s plan set in Appendix B.

2.2 Laboratory Testing

A laboratory testing program consisting of natural moisture contents, Atterberg limits, particle size analysis, and unconfined compressive strength of rock core specimens was conducted by IDOT to determine selected engineering properties of the obtained soil samples. The results of the individual tests are presented on the boring logs in Appendix B.

3.0 Subsurface Conditions

Details of the subsurface conditions encountered at the borings are shown on the boring logs. The general subsurface conditions encountered and their pertinent engineering characteristics are described in the following paragraphs. Conditions represented by the borings should be considered applicable only at the boring locations on the dates shown; the reported conditions may differ at other locations and at other times.

3.1 Generalized Subsurface Profile

The soils at the site are predominantly made up of cohesive materials that are occasionally underlain by more granular behaving material. The upper approximately 20 feet is most likely embankment material from the original road construction. Below the possible fill is approximately 34 feet of natural cohesive soil, generally consisting of silty clay, silty loam, silty clay loam, clay, and clay loam. The standard penetration test N-values range from 0 (weight of hammer) to 18 blows per foot (bpf), unconfined compressive strength values obtained from Rimac testing (Q_u) range from 0.1 to 3.1 tons per square foot (tsf). Moisture contents range from 6 to 32 percent. Below the cohesive soil at boring 1-S was approximately 6.5 feet of sandy loam with an N-value of 4 bpf and a moisture content of 22 percent. The sandy loam transitioned to a 1-foot layer of sand to weathered sandstone with an N-value of 91 bpf. The sandy loam and weathered sandstone layers were absent in boring 2-S.

Bedrock consisting of sandstone was encountered at Elevations 355.7 and 363.0, approximately 62.0 and 54.0 feet below the ground surface at 1-S and 2-S, respectively. The bedrock was cored at boring 1-S from Elevation 355.7 to 345.7. The bedrock is classified as moderately hard with unconfined compressive strengths ranging from 53.6 to 211.2 tsf. Core recoveries of 88 and 95 percent were observed, with corresponding rock quality designation (RQD) values of 25 and 79 percent.

The top 30 to 35 feet of natural soil encountered in the eight borings performed in 1961 were predominantly cohesive materials. The textural classifications included silty clay loam, silty clay, clay, and clay loam. Approximately 5 to 10 feet of granular soils were encountered below the cohesive materials. The granular soils were classified as sand, and sand and gravel. Sandstone was encountered below the granular layers. These borings drilled for the initial bridge design and construction were extended to approximately 51 feet, except for B-5 which was terminated at 40.5 feet. Rock coring was performed in all the 1961 borings except B-4.

The approximate elevations at which the top of bedrock was encountered for both this study and the study performed in 1961 are summarized in Table 1 below. This information indicates that the bedrock surface near the southwest abutment is 7 to 12 feet higher than the rest of the bridge site.

Table 3.1
Bedrock Elevations (Approx.)

Boring No.	Approximate Top of Bedrock Elevation (ft.)
1-S	355.7
2-S	363.0
1*	355.5
2*	355.6
3*	356.2
4*	356.4
5*	368.5
6*	361.0
7*	356.1
8*	356.1

*= boring drilled for 1960's study

3.3 Groundwater

Groundwater was observed during the drilling of both borings performed in 2019, at depths of 21.5 and 18.0 feet (Elevation 396.2 and 399.0, respectively). The presence or absence of groundwater at a particular location does not necessarily indicate that groundwater will be present or absent at that location at other times. Groundwater levels may vary significantly over time due to the effect of seasonal variations in precipitation, water levels in the adjacent Gun Creek as well as Rend Lake, or other factors not evident at the time of exploration. The surface water elevation of the creek during the field exploration was reported at about Elevation 409.5 feet. Based on information provided by Oates, we understand the estimated water surface elevation (EWSE) is approximately 412.6 feet.

4.0 Geotechnical Evaluations

4.1 Earthwork and Slope Stability

Millennia performed slope stability assessments to verify the new integral abutments would be adequately supported by the proposed end slopes. End slopes are currently planned for 2H:1V inclinations, and the proposed slope locations appear to closely match the existing locations. The new integral abutments will be set just inside of the existing abutments.

The parameters used for the stability assessments were based on the results of the field and laboratory investigations, along with Millennia's experience in the area, and are shown on the Summary Stability Profiles provided in Appendix C.

The global stability assessments were conducted for short term (undrained, or total stress), long term (drained, or effective stress), and seismic conditions using SLOPE/W, a computer program from GeoStudio. The results are summarized in the following table:

Table 4.1
Summary of Global Stability Results

Analysis Location	Minimum Computed Factor of Safety		
	Short Term	Long Term	Seismic
North Abutment End Slopes	2.13	1.43	1.01
South Abutment End Slopes	2.00	1.39	1.01

The minimum desired safety factor with regard to the potential for massive, global slope failure is 1.5 for static conditions. For the seismic condition, a factor of safety 1.0 or greater is desired. On this basis, the results of the stability assessments at the sections summarized above are considered acceptable for the short term and seismic conditions.

Although, the long term static condition yielded a factor of safety less than 1.5 for both end slopes, stability is not a concern based on long term performance. To our knowledge, the existing end slopes have remained stable since the original construction over 60 years ago.

Some of the silty soils can be potentially erosive, a mechanism of soil movement unrelated to global stability. Future erosion and shallow, superficial slumps are always a possibility, despite the results of advanced computer modeling for slope stability. Maintaining healthy vegetation, along with appropriate erosion control practices, will reduce the potential for these issues to become problematic.

In addition, the geotechnical conditions between the boring locations are essentially unknown. If the contractor exposes conditions during excavation and other earthwork activities that differ from those indicated at the boring locations, Millennia should be notified to assess the effect (if any) of the unanticipated conditions upon the findings of the global slope stability assessment.

4.2 Settlement

The proposed grade changes will be minimal for the new bridge profile. Therefore, issues related to settlement are not anticipated and have not been evaluated.

4.3 Mining Activity

A review of abandoned coal mines and industrial mineral mines was made using the Illinois State Geological Survey (ISGS) website for mapped mines in Jefferson and Franklin Counties, Illinois. Based on this information, the project site is unlikely to be undermined. The nearest underground coal mine boundary is approximately 1.5 miles southwest of the site, under the Rend Lake Gun Creek Campground. The nearest coal mine shaft is approximately 1.9 miles southeast of the site, near Whittington, Illinois.

4.4 Seismicity

Although several significant areas of seismic activity are present in the central United States, the site area is most directly affected by the Wabash Seismic Zone, located in south and east-central Illinois. The IDOT “Seismic Site Class Determination” was used to determine a Soil Site Class D. We understand that IDOT utilizes the approximate fixity elevation as the point of reference. The AASHTO 2007 Guide Specifications for LRFD Seismic Bridge Design was used with the Site Class D classification to provide acceleration coefficient values S_{DS} and S_{D1}. The results of the Site Class determination and a screenshot of the report from the AASHTO software are presented in Appendix D. Based on the guidelines in the current IDOT Geotechnical Manual, including Table 6.12.2.1.3-1 of that manual, the Seismic Performance Zone is 3. Recommended seismic design parameters are summarized in the following table.

Table 4.2
Summary of Seismic Data

Parameter	Value
Seismic Performance Zone	3
Spectral Response Acceleration, 0.2 Sec, S_{DS}	0.742g
Spectral Response Acceleration, 1.0 Sec, S_{D1}	0.316g
Soil Site Class	D

Based on published information and the IDOT Liquefaction Design Guide, liquefaction analyses are typically performed for the upper 60 feet of a soil profile, since the effects of liquefaction are unlikely to manifest below that depth. The sampled soils obtained in 2019 appear to be susceptible to liquefaction at approximate depths ranging from 23.5 to 28.5 feet (Elev. 393.5 to 388.5) at Boring 2-S. A general assessment of liquefaction potential at the 1960’s borings near Boring 3 (NB center pier) and Boring 4 (NB north abutment) indicate isolated liquefiable layers from approximately Elev. 368 to 363. The potential for liquefaction should not be ignored through these zones unless additional boring information indicates otherwise.

4.5 Scour

Abutment slope protection should be included to protect against scour potential. Countermeasure options for scour at bridge locations could include webwalls to eliminate debris collection between columns, riprap, partially grouted riprap, geotextile sand containers, and sheet piling. Lining the abutment slopes with either Class A4 or A5 stone riprap appears to be appropriate scour protection for the new structures. Skin friction and lateral load design values for driven piles should be ignored in the scour zone. An unadjusted scour depth of 5.3 feet (Elevation 382.4) was provided by Oates. In accordance with Section 2.3.6.3.2 of the IDOT Bridge Manual, the scour depth may be adjusted to 75% of the reported value based on the presence of soft to stiff cohesive soils below the stream bed. An adjusted scour depth of 4.0 feet (Elevation 383.7) is recommended. The recommended design scour elevations are summarized in the table below.

Table 4.3
Summary of Design Scour Elevations

Event/Limit State	**Design Scour Elevations (ft.)**			
	North Abutment	Pier	South Abutment	Item 113
Q100	410.4	383.7	410.4	8
Q200	410.4	383.7	410.4	
Design	410.4	383.7	410.4	
Check	410.4	383.7	410.4	

5.0 Foundation Evaluations and Design Recommendations

5.1 Driven Pile Foundations

The bridge structures may be supported on driven pile foundations. Pile capacities and driving depths have been assessed using the IDOT pile design spreadsheet “Pile Capacity and Length Estimates,” version 1/26/2021. Steel H-piles and metal shell piles are both considered to be feasible for this site. However, metal shell piles are not recommended because of the proximity of rock where a possibility of pile damage during driving may occur. Hard driving is anticipated to penetrate a sufficient distance into sandstone to achieve the maximum factored capacity, particularly for the heavier sections. Numerous available pile sections may be suitable, and final selection would be based on availability and structural requirements such as pile spacing, installation requirements, etc.

The abutments and center piers have been assessed for selected pile sections. Copies of a typical input spreadsheet giving the input parameters for each substructure, and the corresponding summary sheets for the various pile types that are analyzed by the spreadsheet, are included in Appendix E. These tables provide the pile embedment length to develop various capacities, up to that approaching the factored design capacity of the pile. The tables were prepared for pile lengths corresponding to selected depths of the input stratigraphy. Geotechnical losses due to scour and liquefaction were applied as appropriate. In those cases, seismic resistance available exceeds factored resistance available. Data for key assumptions such as pile cutoff elevation and ground surface elevation against pile driving were provided to Millennia by Oates.

Integral abutments are being considered for the new bridge structures. The pile selections were determined using the IDOT Integral Abutment Feasibility Analysis spreadsheet.

The piles exhibited in the tables in Appendix E are the pile sections that are readily available in accordance with the IDOT Geotechnical Manual. The tables below summarize the information provided in Appendix E. Steel H-piles should be driven into rock to their maximum required bearing, as indicated on the IDOT pile design length spreadsheets. It should be noted that H-Piles driven into sandstone may run shorter (or longer) than the IDOT pile design length spreadsheets estimate.

Table 5.1
Estimated Pile Lengths
Dual Structures – North Abutments (Boring 1-S)

Pile Type and Size	Nominal Required Bearing (kips)	Factored Resistance Available (kips)	Estimated Pile Length (ft)	Pile Cutoff Elevation (ft)
HP 8x36	286	157	59	412.4
HP 10x42	335	184	59	412.4
HP 10x57	454	250	60	412.4
HP 12x53	418	230	59	412.4
HP 12x63	497	273	60	412.4
HP 12x74	589	324	61	412.4
HP 12x84	664	365	61	412.4
HP 14x73	578	318	60	412.4
HP 14x89	705	388	61	412.4
HP 14x102	810	445	61	412.4
HP 14x117	929	511	62	412.4

Table 5.2
Estimated Pile Lengths
Dual Structures – South Abutments (Borings 2-S and B-1)

Pile Type and Size	Nominal Required Bearing (kips)	Factored Resistance Available (kips)	Estimated Pile Length (ft)	Pile Cutoff Elevation (ft)
HP 8x36	286	157	51	412.4
HP 10x42	335	184	51	412.4
HP 10x57	454	250	52	412.4
HP 12x53	418	230	51	412.4
HP 12x63	497	273	52	412.4
HP 12x74	589	324	52	412.4
HP 12x84	664	365	53	412.4
HP 14x73	578	318	52	412.4
HP 14x89	705	388	52	412.4
HP 14x102	810	445	53	412.4
HP 14x117	929	511	54	412.4

Table 5.3
Estimated Pile Lengths
Dual Structures – Center Piers (Boring B-3)

Pile Type and Size	Nominal Required Bearing (kips)	Factored Resistance Available (kips)	Estimated Pile Length (ft.)	Pile Cutoff Elevation (ft)
HP 8x36	286	157	59	412.4
HP 10x42	335	184	59	412.4
HP 10x57	454	250	60	412.4
HP 12x53	418	230	59	412.4
HP 12x63	497	273	60	412.4
HP 12x74	589	324	61	412.4
HP 12x84	664	365	61	412.4
HP 14x73	578	318	60	412.4
HP 14x89	705	388	61	412.4
HP 14x102	810	445	61	412.4
HP 14x117	929	511	62	412.4

5.2 Lateral Load Capacity Considerations

Lateral load resistance and induced lateral deflection are typically assessed using finite difference computer models based on the lateral modulus-of-subgrade reaction, such as LPILE. Recommended design values for driven pile foundations are presented on the following tables.

Table 5.4
Parameters for Use in LPILE Analysis at Boring 1-S (2019)
Northbound and Southbound Northern Abutments

Elevation (ft)	LPILE Soil Type	Effective Unit Weight (pcf)	Undrained Cohesion (psf)	Unaxial Compressrive Strength (psi)	Strain at 50% Maximum Stress	Angle of Internal Friction (degrees)	p-y Soil Modulus K_{static} (pci)
418-414	Stiff Clay w/o Free Water	120	3,100	N/A	0.005	N/A	1,020
414-403	Soft Clay (Matlock)	120	250	N/A	0.020	N/A	30
403-399	Stiff Clay w/o Free Water	120	1,800	N/A	0.006	N/A	540
399-379	Stiff Clay w/ Free Water	58*	775	N/A	0.010	N/A	125
379-373	Stiff Clay w/ Free Water	58*	1,600	N/A	0.007	N/A	530
373-368	Stiff Clay w/ Free Water	58*	600	N/A	0.020	N/A	58
368-363	Soft Clay (Matlock)	58*	400	N/A	0.020	N/A	30
363-357	Sand (Reese)	58*	N/A	N/A	N/A	26	10*
357-356	Sand (Reese)	58*	N/A	N/A	N/A	38	138*

pcf = pounds per cubic foot psf = pounds per square foot pci = pounds per cubic inch
*= submerged value

Table 5.5
Parameters for Use in LPILE Analysis at Boring 2-S (2019)
Northbound and Southbound Southern Abutments

Elevation (ft)	LPILE Soil Type	Effective Unit Weight (pcf)	Undrained Cohesion (psf)	Unaxial Compressrive Strength (psi)	Strain at 50% Maximum Stress	Angle of Internal Friction (degrees)	p-y Soil Modulus K_{static} (pci)
417-411	Soft Clay (Matlock)	120	500	N/A	0.020	N/A	30
411-408.5	Soft Clay (Matlock)	120	100	N/A	0.020	N/A	30
408.5-401	Stiff Clay w/o Free Water	120	1,733	N/A	0.007	N/A	570
401-398.5	Soft Clay (Matlock)	58*	500	N/A	0.020	N/A	30
398.5-393.5	Stiff Clay w/ Free Water	58*	1,300	N/A	0.008	N/A	440
393.5-388.5	Soft Clay (Matlock)	58*	200	N/A	0.020	N/A	30
388.5-381	Stiff Clay w/ Free Water	58*	900	N/A	0.009	N/A	250
381-373	Stiff Clay w/ Free Water	58*	1,850	N/A	0.006	N/A	605
373-368	Stiff Clay w/ Free Water	58*	600	N/A	0.020	N/A	58
368-363	Stiff Clay w/ Free Water	58*	1,900	N/A	0.006	N/A	620

pcf = pounds per cubic foot psf = pounds per square foot pci = pounds per cubic inch
*= submerged value

Table 5.6
Parameters for Use in LPILE Analysis at Boring 3 (1961)
Northbound and Southbound Center Piers

Elevation (ft)	LPILE Soil Type	Effective Unit Weight (pcf)	Undrained Cohesion (psf)	Unaxial Compressrive Strength (psi)	Strain at 50% Maximum Stress	Angle of Internal Friction (degrees)	p-y Soil Modulus K_{static} (pci)
401-383	SCOUR ZONE						
383-364	Stiff Clay w/ Free Water	58*	1,500	N/A	0.007	N/A	500
364-361	Sand (Reese)	58*	N/A	N/A	N/A	28	13
361-359	Stiff Clay w/ Free Water	58*	1,500	N/A	0.007	N/A	500
359-356	Sand (Reese)	58*	N/A	N/A	N/A	36	97
372-370	Stiff Clay w/ Free Water	63*	2,700	N/A	0.006	N/A	850
370-366	Stiff Clay w/ Free Water	135	5,000	N/A	0.004	N/A	1,300

pcf = pounds per cubic foot psf = pounds per square foot pci = pounds per cubic inch
*= submerged value

Piles should be maintained at a spacing no closer than three pile diameters, center-to-center, so that stress overlap at the bearing level can be avoided, to reduce lateral capacity interaction, and so that possible installation problems associated with one structural member do not impact the integrity of the adjacent member.

The LPile parameters provided above do not account for the temporary effects of liquefaction on the lateral capacity of the driven pile foundations. For lateral capacity reductions with the estimated liquefiable soils, the following tables should be referenced.

Table 5.7
Parameters for Use in LPILE Analysis of Liquefiable Layers at Boring 3 (1961)
Northbound and Southbound Center Piers

Elevation (ft)	LPILE Soil Type	Effective Unit Weight (pcf)	Undrained Cohesion (psf)	Strain at 50% Maximum Stress	Angle of Internal Friction (degrees)	p-y Soil Modulus K_{static} (pci)
364-361	Soft Clay (Matlock)	58*	200	0.020	N/A	30

pcf = pounds per cubic foot psf = pounds per square foot pci = pounds per cubic inch
*= submerged value

Table 5.8
Parameters for Use in LPILE Analysis of Liquefiable Layers at Boring 2-S (2019) Northbound and Southbound Southern Abutments

Elevation (ft)	LPILE Soil Type	Effective Unit Weight (pcf)	Undrained Cohesion (psf)	Strain at 50% Maximum Stress	Angle of Internal Friction (degrees)	p-y Soil Modulus K_{static} (pci)
393.5-388.5	Silt	58*	200	0.020	26	10*

pcf = pounds per cubic foot psf = pounds per square foot pci = pounds per cubic inch
*= submerged value

6.0 Construction Considerations

6.1 Temporary Sheeting and Soil Retention

The construction activities should be performed in accordance with the current IDOT Standard Specifications for Road and Bridge Construction (IDOT Standard Specs). Trenching, excavating, and bracing should be performed in accordance with Occupational Safety and Health Administration (OSHA) regulations, and other applicable regulatory agencies. In accordance with the OSHA excavation standards, the soil at the site is considered to be Type C, which requires a side slope for excavations no steeper than 1.5H:1.0V. However, worker safety and classification of the excavation soil is the responsibility of the contractor. The excavation side slopes for structure foundations may interfere with existing utilities. This will require a temporary soil retention system such as a cantilever sheet pile wall, sheeting, or other temporary support.

Traffic along I-57 will be maintained by utilizing staged construction. It appears as though either a temporary sheet pile, which includes cantilever temporary sheet piling, or a soil retention system, will be feasible at the abutments. Cantilever sheet pile systems may be designed using IDOT Design Guide 3.13.1 – Temporary Sheet Piling Design. Temporary soil retention systems should be designed by an Illinois licensed structural engineer retained by the construction contractor.

6.2 Cofferdam

The following information is based on the understanding that the EWSE is approximately 412.55 for Gun Creek and the fact that driven piles are planned to support the proposed bridge. Cofferdams are recommended for installation of the center pier piles. Per IDOT Bridge Manual Section 2.3.6.4.2, a Type 2 Cofferdam will be required due to more than 6 feet of water being anticipated at this location. Millennia recommends including a seal coat in the design since soft silty clay soils may be present near the proposed bottom of the cofferdam. The sheet pile depths, dimensions, and properties should be the responsibility of the contractor in the design of the cofferdam.

6.3 Subgrade Water Protection

Groundwater seepage should be anticipated for excavations extending more than a few feet below the roadway level along I-57 if construction occurs during periods when the water level approaches the design high water elevation. It is anticipated that excavations for the pile cap foundations may be adequately dewatered using sump and pump methods.

6.4 Driven Pile Installation

The driven piles are to be furnished and installed according to the requirements of Section 512 of the IDOT Standard Specs. Millennia recommends that at least one test pile be driven at each substructure location, in accordance with Section 512.15. The piles should be fitted with reinforced tips to reduce the potential for damage during driving.

6.5 Subgrade, Fill, and Backfill

Earthwork activities including backfill and fill should be performed in accordance with Section 205 of the IDOT Standard Specs.

7.0 Closing

This report has been prepared for the exclusive use of Oates Associates, Inc. and the Illinois Department of Transportation for use in the design and construction of the proposed I-57 over Gun Creek bridge structures project near Whittington, Franklin County, Illinois. This report has been prepared in accordance with generally accepted soil and foundation engineering practices. No other warranty, expressed or implied, is made to the professional advice and recommendations included herein. This report is not for use by parties other than those named or for purposes other than those stated herein. It may not contain sufficient information for the use of other parties or for other purposes.

If there is a substantial lapse of time between the submission of this report and the start of work at the site, or if conditions have changed due to natural causes or construction operations at or adjacent to the site, this report should be reviewed by Millennia to determine the applicability of the analyses and recommendations considering the changed conditions and time lapse. The report should also be reviewed by Millennia if changes occur in structure location, size, and type, or in the planned loads, elevations, grading plans, and project concepts.

These analyses and recommendations are based on data obtained from site reconnaissance, the borings performed for this study and other pertinent information presented herein. This report does not reflect any variations between, beyond, or below the borings. Should such variations become evident, it may be necessary to re-evaluate the recommendations of this report after performing on-site observation during the construction period and noting the characteristics of any such variation.

We appreciate this opportunity to be of service to you and would be pleased to discuss any aspect of this report with you at your convenience.

Sincerely,

Millennia Professional Services, Ltd.

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Appendix A:

Figure 1: Vicinity Map
Figure 2: Boring Location Plan / TS&L Plan
Figure 3.1: Northbound Subsurface Profile
Figure 3.2: Southbound Subsurface Profile

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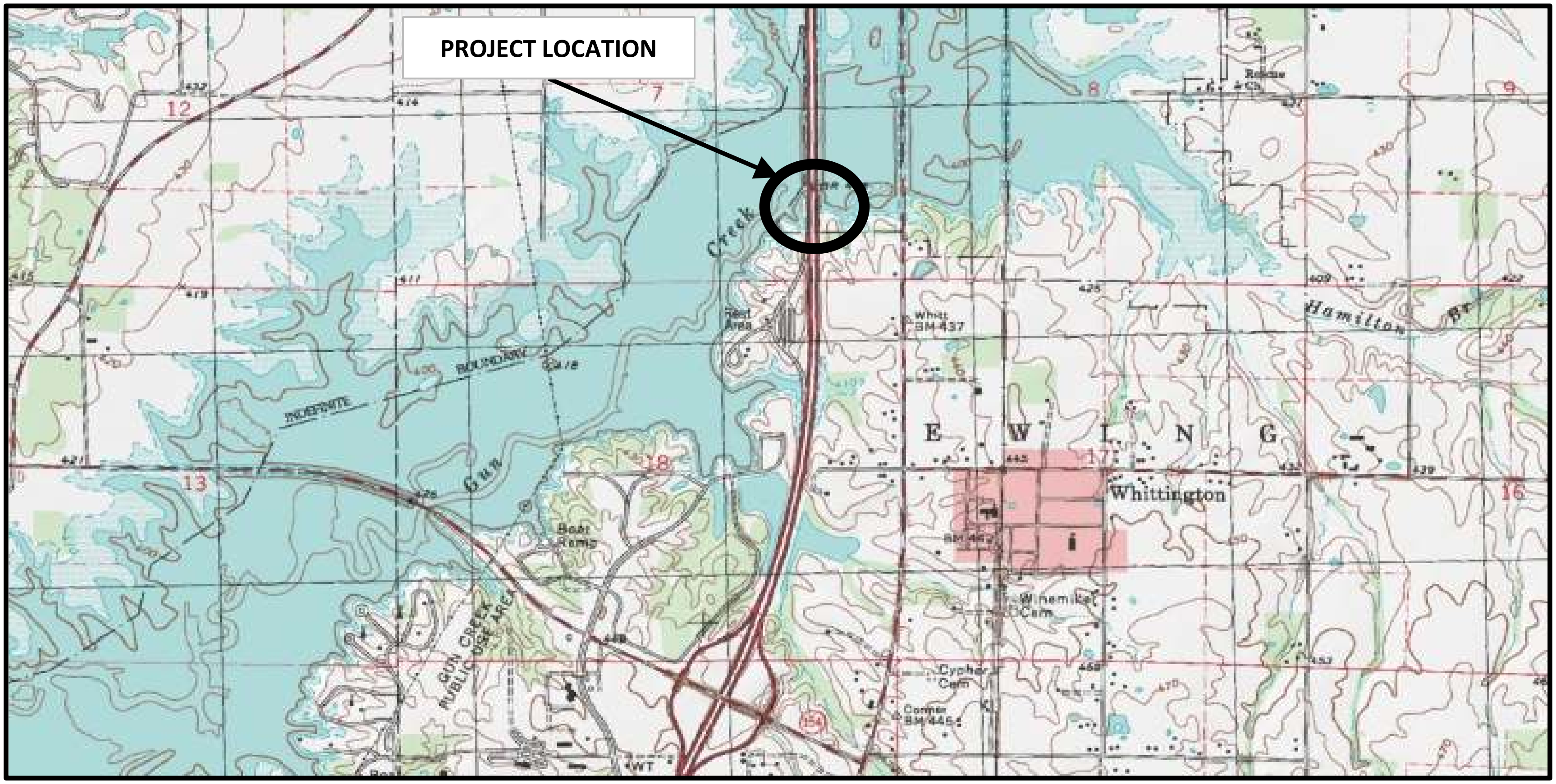

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Image obtained from MyTopo

*Not to scale

FIGURE 1: VICINITY MAP

Interstate 57 over Gun Creek
Structure Nos. 028-0093 (NB) & 028-0094 (SB)
Franklin County, IL

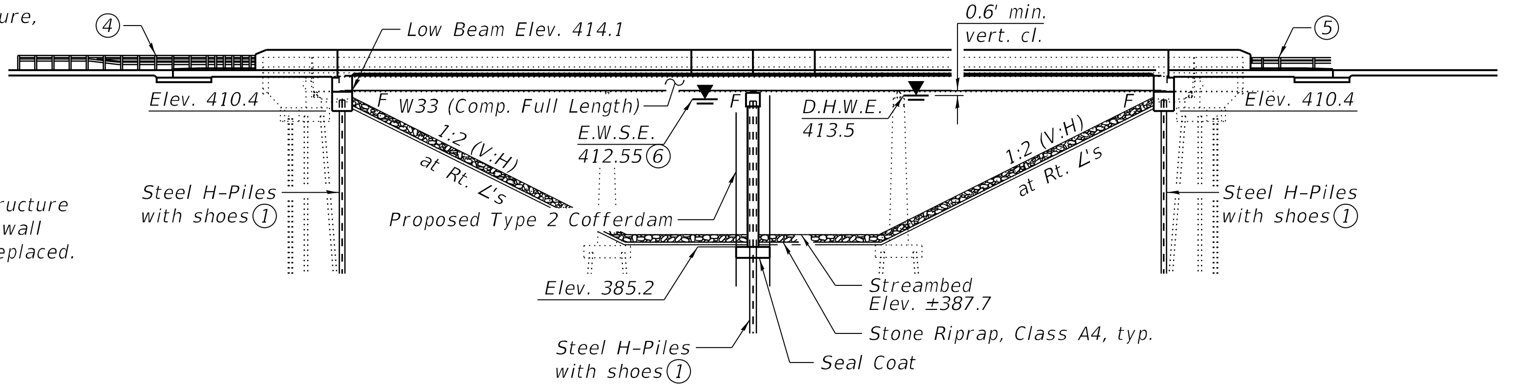
Drawn by:	B. Fisher	Checked by:	JLO
Project No.:	MG19034.06	Date:	7/10/2023

Bench Mark: BM 8 Sawed square on northwest wingwall of northbound structure, SN 028-0013, Sta. 101+80.9, 27.8' LT, Elev. 417.62

Existing Structure: SN 028-0013 (N.B.) and 028-0014 (S.B.) were originally built in 1962 as F.A.I. 57, Section 28-1B-F. The deck, bearings, and expansion were replaced in 1993 for SN 028-0013 (N.B.) as Section (28-1B)D and 1994 for SN 028-0014 (S.B.) as Section (28-1B)D-1. The back to back abutment length is 163'-0" and the out to out deck width is 43'-2". Each structure consists of a three span steel 33WF118 superstructure supported by concrete stub abutments founded on steel H-piles and solid wall piers on steel H-pile supported footings. Structures to be removed and replaced.

Traffic Control: Two traffic lanes will be maintained in each direction by utilizing staged construction.

Salvage: None.



ELEVATION

HIGHWAY CLASSIFICATION

F.A.I. Rte. 57 - I-57
Functional Class: Interstate
ADT (one-way): 17,250 (2017) / 25,030 (2042)
ADTT (one-way): 5,100 (2017) / 7,400 (2042)
DHV (one-way): 2,255 (2042)
Design Speed: 70 m.p.h
Posted Speed: 70 m.p.h

LOADING HL-93

Allow 50#/sq. ft. for future wearing surface.

DESIGN SPECIFICATIONS

2020 AASHTO LRFD Bridge Design Specifications, 9th Edition

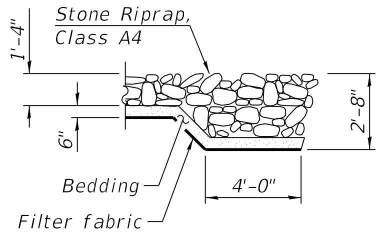
DESIGN STRESSES

FIELD UNITS

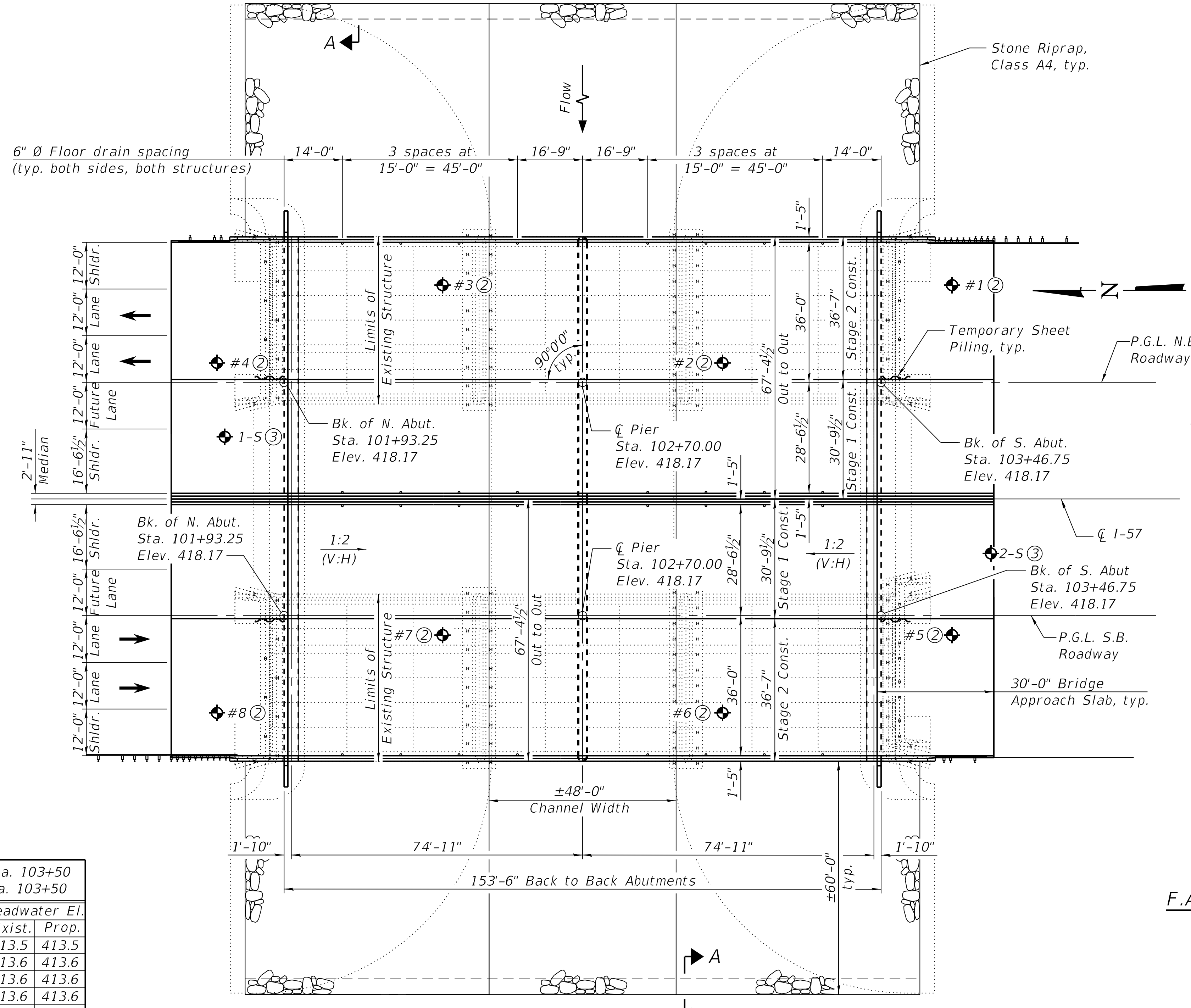
f'c = 3,500 psi
f'c = 4,000 psi (Superstructure Concrete)
fy = 60,000 psi (Reinforcement)
fy = 50,000 psi (M270 Grade 50)

SEISMIC DATA

Seismic Performance Zone (SPZ) = 3
Design Spectral Acceleration at 1.0 sec. (SD1) = 0.320g
Design Spectral Acceleration at 0.2 sec. (SDS) = 0.753g
Soil Site Class = D



SECTION A-A



PLAN

Notes:

① Space piles to miss existing battered piles.
② 1961 Boring
③ 2019 Boring
④ Traffic Barrier Terminal
Type 5, Std. 631026 (N.B. Structure)
Type 6, Std. 631031 (S.B. Structure)
⑤ Traffic Barrier Terminal
Type 5, Std. 631026 (S.B. Structure)
Type 6, Std. 631031 (N.B. Structure)
⑥ The EWSE may not be appropriate to use for the design of the cofferdams. The stage data for Rend Lake may be more appropriate for the cofferdam elevation. The District should be contacted for the cofferdam elevation.
⑦ All structural steel shall be metallized.

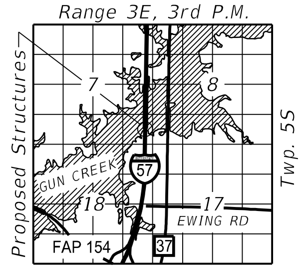
DESIGN SCOUR ELEVATION TABLE

Event / Limit State	Design Scour Elevations (ft.)			
	N. Abut.	Pier	S. Abut.	Item 113
Q100	410.4	382.6	410.4	8
Q200	410.4	382.4	410.4	
Design	410.4	382.6	410.4	
Check	410.4	382.4	410.4	

WATERWAY INFORMATION

Drainage Area = 41.9 sq. mi.
Exist. Overtopping Elev. = 417.5 at Sta. 103+50
Prop. Overtopping Elev. = 417.8 at Sta. 103+50

Flood	Freq. Yr.	Q C.F.S.	Opening Ft²		Nat. H.W.E.	Head - Ft.		Headwater El.	
			Exist.	Prop.		Exist.	Prop.	Exist.	Prop.
Ten-Year	10	3,510	2,375	2,440	413.5	0.0	0.0	413.5	413.5
Design	50	5,400	2,375	2,440	413.5	0.1	0.1	413.6	413.6
	100	6,210	2,375	2,440	413.5	0.1	0.1	413.6	413.6
	200	7,100	2,375	2,440	413.5	0.1	0.1	413.6	413.6
Max. Calc.	500	8,290	2,375	2,440	413.5	0.2	0.2	413.7	413.7



LOCATION SKETCH

GENERAL PLAN & ELEVATION
I-57 OVER GUN CREEK
F.A.I. RTE. 57 - SEC. (28-2)B-2;(28-1)B-2
FRANKLIN COUNTY
STA. 102+70.00
STRUCTURE NO. 028-0093 (N.B.)
STRUCTURE NO. 028-0094 (S.B.)

OATES ASSOCIATES
www.oatesassociates.com
ILLINOIS DESIGN FIRM LICENSE NO.: 184.001115

USER NAME =	DESIGNED -	REVISED -
	CHECKED -	REVISED -
PLOT SCALE =	DRAWN -	REVISED -
PLOT DATE = 7/10/2023	CHECKED -	REVISED -

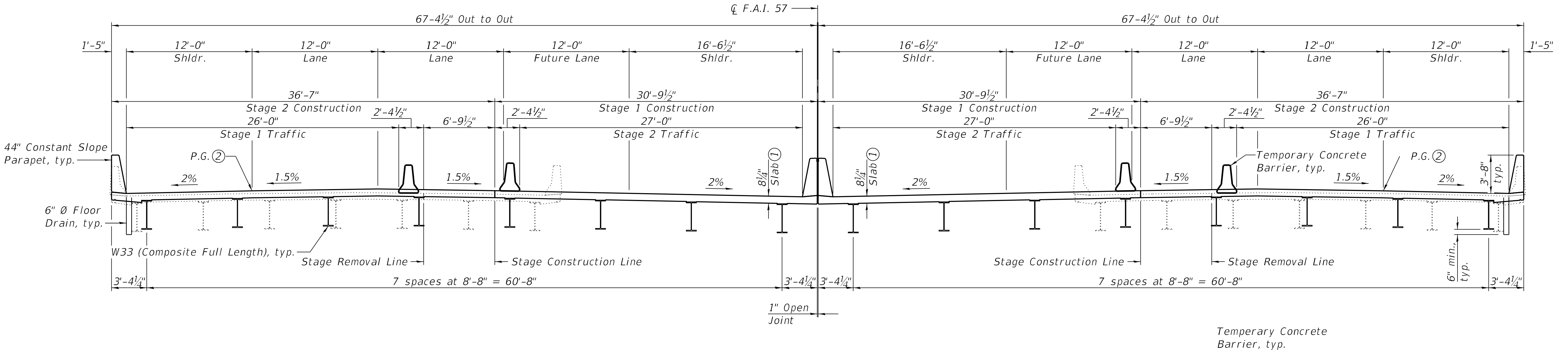
STATE OF ILLINOIS
DEPARTMENT OF TRANSPORTATION

SHEET 1 OF 2 SHEETS

F.A.I. RTE.	SECTION	COUNTY	TOTAL SHEETS	SHEET NO.
57	(28-2)B-2;(28-1)B-2	FRANKLIN		

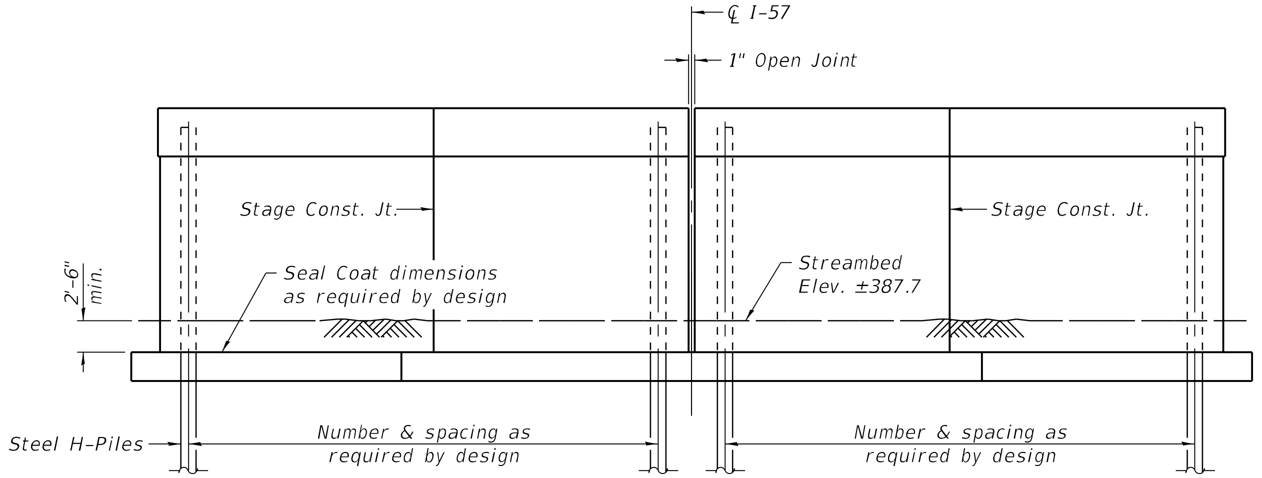
CONTRACT NO. 78884
ILLINOIS FED. AID PROJECT

FILE NAME: H:\P\18120\18120.006 - I-57 over Gun Creek\Bridge\TSL\Microstation\OA_0280093_0094-78688-001-General Plan & Elevation.dgn

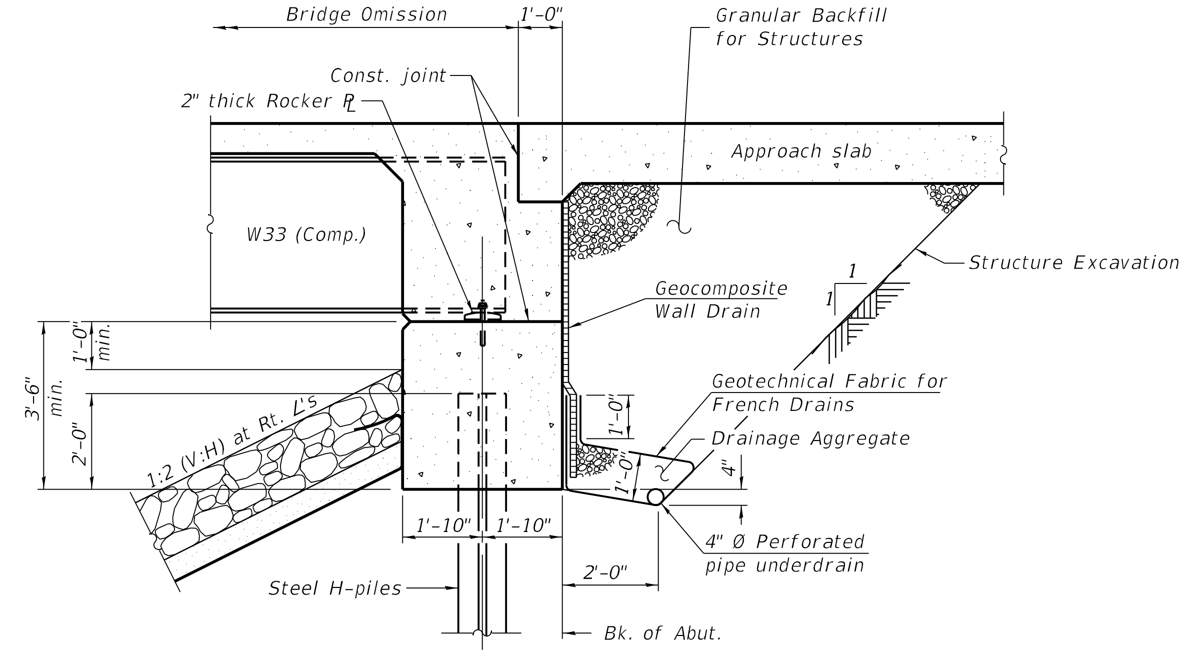


CROSS SECTION

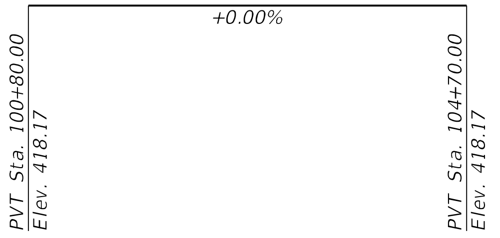
Notes:
① Prior to grinding
② After grinding



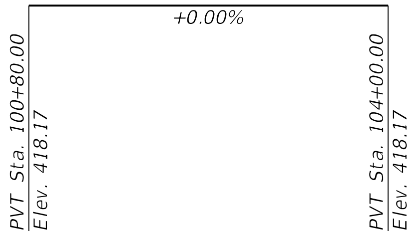
PIER SKETCH



SECTION THRU INTEGRAL ABUTMENT



PROFILE GRADE - F.A.I. RTE. 57 (N.B.)
(along P.G.L.)



PROFILE GRADE - F.A.I. RTE. 57 (S.B.)
(along P.G.L.)

DETAILS
I-57 OVER GUN CREEK
F.A.I. RTE. 57 - SEC. (28-2)B-2;(28-1)B-2
FRANKLIN COUNTY
STA. 102+70.00
STRUCTURE NO. 028-0093 (S.B.)
STRUCTURE NO. 028-0094 (N.B.)

FILE NAME: H:\P\18120\18120.006 - I-57 over Gun Creek\Bridge\TSL\Microstation\OA_0280093_0094-78688-002-Details.dgn

OATES ASSOCIATES
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ILLINOIS DESIGN FIRM LICENSE NO.: 184.001115

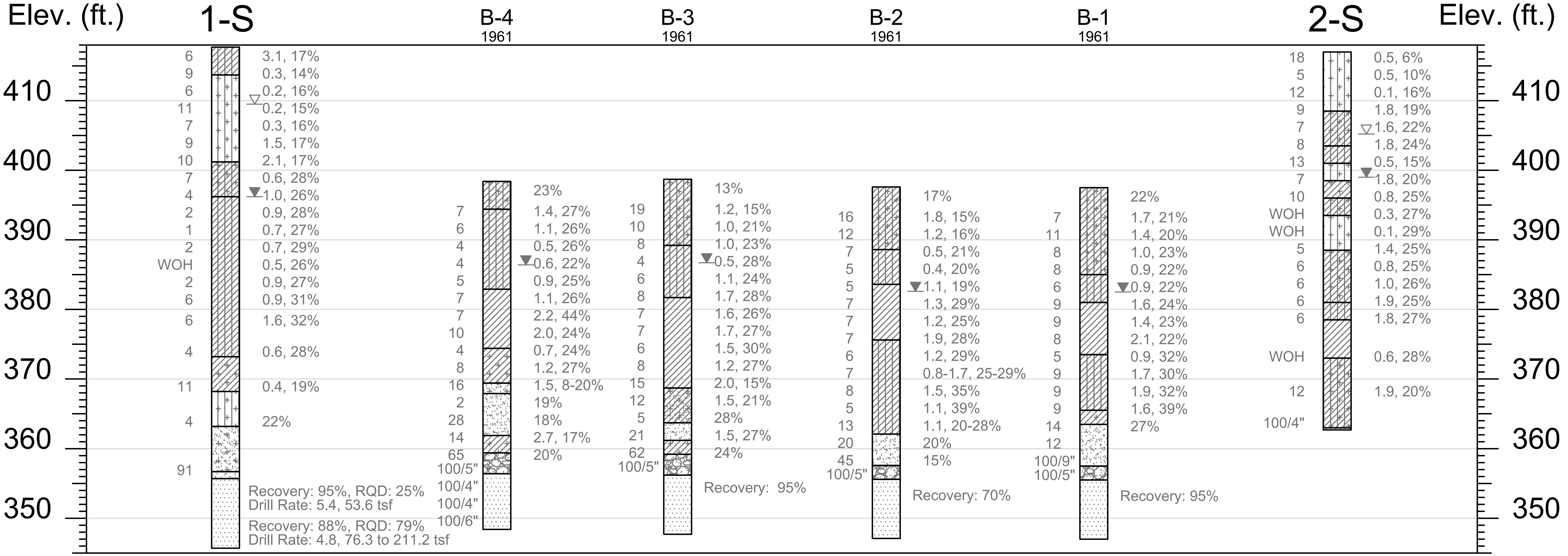
USER NAME =	DESIGNED -	REVISED -	
	CHECKED -	REVISED -	
PLOT SCALE =	DRAWN -	REVISED -	
PLOT DATE = 7/10/2023	CHECKED -	REVISED -	

STATE OF ILLINOIS
DEPARTMENT OF TRANSPORTATION

SHEET 2 OF 2 SHEETS

F.A.I. RTE.	SECTION	COUNTY	TOTAL SHEETS	SHEET NO.
57	(28-2)B-2;(28-1)B-2	FRANKLIN		
		CONTRACT NO. 78884		
	ILLINOIS	FED. AID PROJECT		

STRUCTURE 028-0093



Note: Elevations are approximate. Actual conditions between borings are unknown, and are subject to change. Horizontal scale shown is only for reference.

STRATIGRAPHY KEY:

▨ CLAY	▨ SANDSTONE	▨ SILTY CLAY
▨ CLAY LOAM	▨ SANDY CLAY	▨ SILTY CLAY LOAM
▨ SAND	▨ SANDY CLAY LOAM	▨ SILTY LOAM
▨ SAND AND GRAVEL	▨ SANDY LOAM	

BORING DATA KEY:

Boring ID

N-Value (bpf)

Stratigraphy

Rimac Value (tsf), Moisture Content (%)

▽ Surface water elevation

▼ Groundwater level encountered while drilling

SCALE: 1":15'

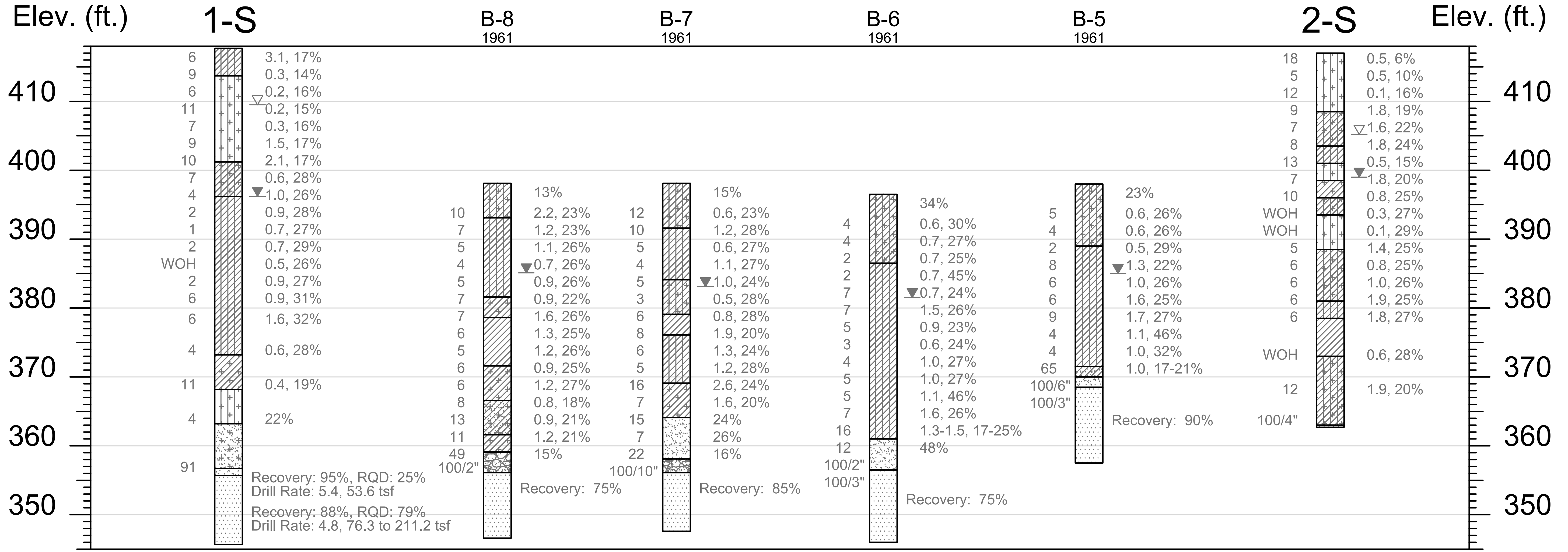
FIGURE 3.1:

NORTHBOUND SUBSURFACE PROFILE

PROJECT NAME:	PROJECT No.:	DRAWN BY:	CHECKED BY:
Interstate 57 Over Gun Creek	MG19034.06	B. FISHER	J. SCHAEFFER
		12/1/2020	12/1/2020

MILLENNIA PROFESSIONAL SERVICES

STRUCTURE 028-0094



Note: Elevations are approximate. Actual conditions between borings are unknown, and are subject to change. Horizontal scale shown is only for reference.

STRATIGRAPHY KEY:

▨ CLAY	▨ SANDSTONE	▨ SILTY CLAY
▨ CLAY LOAM	▨ SANDY CLAY	▨ SILTY CLAY LOAM
▨ SAND	▨ SANDY CLAY LOAM	▨ SILTY LOAM
▨ SAND AND GRAVEL	▨ SANDY LOAM	

BORING DATA KEY:

Boring ID
N-Value (bpf)
Stratigraphy
Rimac Value (tsf) , Moisture Content (%)
▽ Surface water elevation
▼ Groundwater level encountered while drilling

SCALE: 1":15'

FIGURE 3.2:

SOUTHBOUND SUBSURFACE PROFILE

PROJECT NAME:	PROJECT No.:	DRAWN BY:	CHECKED BY:
Interstate 57 Over Gun Creek	MG19034.06	B. FISHER	J. SCHAEFFER
		12/1/2020	12/1/2020

MILLENNIA
PROFESSIONAL
SERVICES

Appendix B:

Boring Logs and Rock Core Photos

Illinois Department of Transportation
Memorandum

To: Carrie Nelsen Attn: Dave Piche
From: Keith Roberts By: Aaron Hayes
Subject: Boring Logs
Date: November 20, 2019

FAI 57 (I-57) over Gun Creek
Structure 028-0013 (Ex.)
Structure 028-0014 (Ex.)
Section (28-1)B-2
Franklin County

Foundation boring logs have been obtained for the above listed structures and are attached. Please note the borings were completed on two separate occasions.

Boring 1-S, near the north abutments, shows a layer of potentially liquefiable soils at a depth of 49.5 to 60.0 feet. Boring 2-S, near the south abutments, shows layers of potentially liquefiable soils at depths of 16.0 to 18.5 feet and 23.5 to 28.5 feet. A liquefaction analysis should be completed once the proposed structures' final dimensions are determined.

Borings completed in 1961 before the existing structures were constructed have been attached for additional information regarding the depth to bedrock. Also attached is a General Plan and Elevation sheet from the 1961 plans showing the old boring locations.

Attachments
AWH:ah

cc: Materials Geotechnical Unit\Boring Logs using gINT\State Structures\Franklin

SOIL BORING LOG

Page 1 **of** 2

Date 4/9/19

ROUTE I-57 **DESCRIPTION** Structures over Gun Creek **LOGGED BY** L. Estel

SECTION (28-1)B-2 **LOCATION** Mile Post 78.9 (Median near North Abutments), **SEC.** 7, **TWP.** 5S, **RNG.** 3E, **PM**

COUNTY Franklin **DRILLING METHOD** Hollow stem auger (8" O.D., 3.25" I.D.) **HAMMER TYPE** Auto SPT 140 lbs

STRUCT. NO. 028-0013 & 028-0014
Station 102+70

BORING NO. 1-S
Station 101+78
Offset 16.0ft LT of Med. Alignment
Ground Surface Elev. 417.7 **ft**

Surface Water Elev. 409.5 **ft**
Stream Bed Elev. 390.1 **ft**

Groundwater Elev.:
▽ **First Encounter** 396.2 **ft**
▼ **Upon Completion** ____ **ft**
▼ **After** ____ **Hrs.** ____ **ft**

		DEPTH (ft)	BLOWS	UCS Qu (tsf)	MOIST (%)
V. Stiff Brown, Moist SILTY CLAY			1		
			3	3.1	17
			3	B	
	413.70				
Soft Brown, Moist SILTY LOAM			2		
		-5	6	0.3	14
			3	S	
			2		
			3	0.2	16
			3	S	
			4		
		-10	6	0.2	15
			5	S	
			2		
			4	0.3	16
			3	S	
	403.20		2		
Stiff Brown, Moist SILTY LOAM		-15	5	1.5	17
			4	B	
	401.20				
V. Stiff Brownish Grey, Moist SILTY CLAY LOAM			2		
			5	2.1	17
			5	B	
	398.70				
			1		
		-20	3	0.6	28

		DEPTH (ft)	BLOWS	UCS Qu (tsf)	MOIST (%)
M. Stiff Grey, Moist SILTY CLAY LOAM with ORGANICS PI > 12 (Est. based on visual ID and historical data) *(continued)*▽			4	B	
	396.20		1		
M. Stiff Grey and mottled Brown, Moist to Wet SILTY CLAY to CLAY PI > 12 (Est. based on visual ID and historical data)			1	1	26
			3	B	
			WOH		
		-25	1	0.9	28
			1	B	
			WOH		
			WOH	0.7	27
			1	B	
			WOH		
		-30	1	0.7	29
			1	E	
			WOH		
			WOH	0.5	26
			WOH	B	
			WOH		
		-35	1	0.9	27
			1	B	
			2		
			3	0.9	31
			3	B	
	378.70				
		-40	1		

The Unconfined Compressive Strength (UCS) Failure Mode is indicated by (B-Bulge, S-Shear, P-Penetrometer, E-Estimated)
Abbreviations W.O.H - Sampler Advanced By Weight of Hammer, W.O.P - Advanced by Weight of Pipe, B.S. - Before Seating
The SPT (N value) is the sum of the last two blow values in each sampling zone (AASHTO T206) BBS, from 137 (Rev. 8-99)

SOIL BORING LOG

Page 2 of 2

Date 4/9/19

ROUTE I-57 **DESCRIPTION** Structures over Gun Creek **LOGGED BY** L. Estel

SECTION (28-1)B-2 **LOCATION** Mile Post 78.9 (Median near North Abutments), **SEC.** 7, **TWP.** 5S, **RNG.** 3E, **PM**

COUNTY Franklin **DRILLING METHOD** Hollow stem auger (8" O.D., 3.25" I.D.) **HAMMER TYPE** Auto SPT 140 lbs

STRUCT. NO. 028-0013 & 028-0014
Station 102+70

BORING NO. 1-S
Station 101+78
Offset 16.0ft LT of Med. Alignment
Ground Surface Elev. 417.7 ft

Surface Water Elev. 409.5 ft
Stream Bed Elev. 390.1 ft

Groundwater Elev.:
▽ **First Encounter** 396.2 ft
▼ **Upon Completion** ft
▼ **After** Hrs. ft

	DEPTH (ft)	BLOWS	UCS Qu (tsf)	MOIST (%)
Stiff Brown and Grey, Moist to Wet SILTY CLAY to CLAY PI > 12 (Est. based on visual ID and historical data) *(continued)*		3 3	1.6 B	32
373.20				
M. Stiff dark Grey, Moist CLAY LOAM PI > 12 (Est. based on visual ID and historical data)	-45	1 2 2	0.6 B	28
368.20				
Soft dark Grey, Moist SILTY LOAM % Fines < #200: 75%, PI = 10, LL = 27 (Est. based on visual ID and historical data)	-50	1 6 5	0.4 B	19
363.20				
Loose Grey, Moist fine SANDY LOAM (non-plastic) 77% SAND, 14% SILT, 6% CLAY (Lab 23) Bottom of hole @ 72.0 ft Elevation referenced to BM 8, Sawed Square at NW Corner of SN 028-0013; EL. 417.62 To convert "N" values to "N60", multiply by 1.5	-55	WOH 1 3		22
	-60			

	DEPTH (ft)	BLOWS	UCS Qu (tsf)	MOIST (%)
356.70		1		
Dense Grey, Moist fine SAND to weathered SANDSTONE		41 50		
355.70				
Borehole continued with rock coring.				
	-65			
	-70			
	-75			
	-80			

The Unconfined Compressive Strength (UCS) Failure Mode is indicated by (B-Bulge, S-Shear, P-Penetrometer, E-Estimated)
Abbreviations W.O.H - Sampler Advanced By Weight of Hammer, W.O.P - Advanced by Weight of Pipe, B.S. - Before Seating
The SPT (N value) is the sum of the last two blow values in each sampling zone (AASHTO T206) BBS, from 137 (Rev. 8-99)

File Name S:\MATERIALS GEOTECHNICAL UNIT\BORING LOGS USING GINT\STATE STRUCTURES\FRANKLIN\028.0013 & 14 I57 OVER GUN CREEK 2019.GPJ Data Template D6TEMPLT.GDT Date Printed 11/19/19
Latitude 38.1004671 Longitude -88.9116877 Datum NAD83 Job Number

Illinois Department of Transportation
Division of Highways
District 9

ROCK CORE LOG

Date 4/9/19

ROUTE I-57 **DESCRIPTION** Structures over Gun Creek **LOGGED BY** L. Estel

SECTION (28-1)B-2 **LOCATION** Mile Post 78.9 (Median near North Abutments), **SEC.** 7, **TWP.** 5S, **RNG.** 3E, **PM**

COUNTY Franklin **CORING METHOD** Conventional rotary with water

STRUCT. NO. 028-0013 & 028-0014
Station 102+70

BORING NO. 1-S
Station 101+78
Offset 16.0ft LT of Med. Alignment
Ground Surface Elev. 417.7 **ft**

CORING BARREL TYPE & SIZE NV3 5FT NWJ

Core Diameter 2 **in**
Top of Rock Elev. 355.70 **ft**
Begin Core Elev. 355.70 **ft**

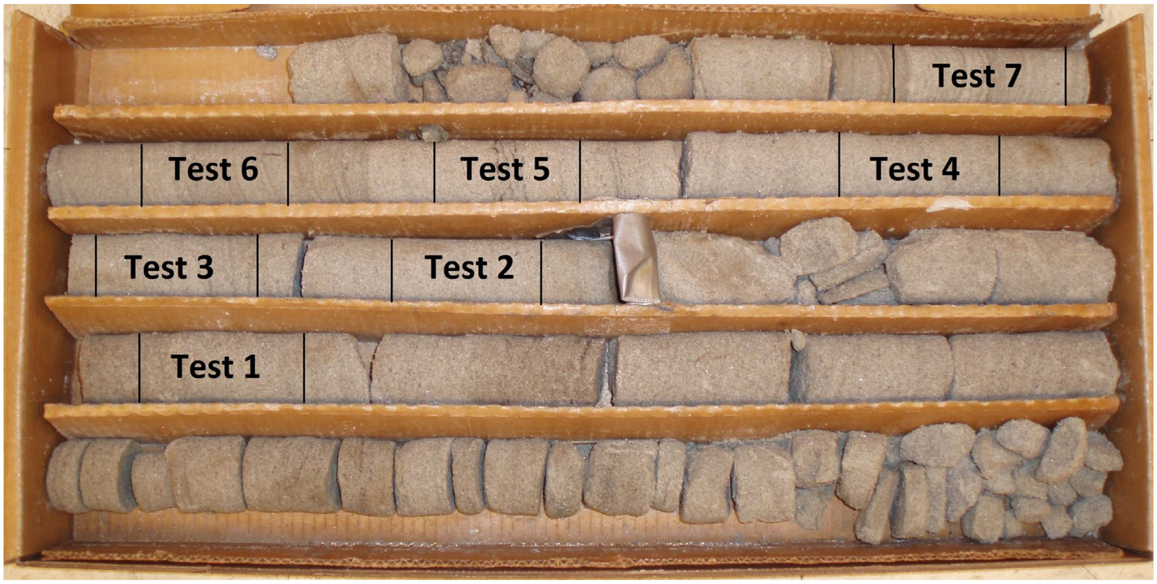
		DEPTH (ft)	**CORE (#)**	**RECOVERY (%)**	**R.Q.D. (%)**	**CORE TIME (min/ft)**	**STRENGTH (tsf)**
Light Brown and Grey SANDSTONE, Dry, Fined Grained, Thin Bedded, Moderately Hard Field Hardness	355.70	-65	1	95	25	5.4	53.6
Light Grey with Brown SANDSTONE, Dry, Fined Grained, Thin Bedded, Moderately Hard Field Hardness	345.70	-70	2	88	79	4.8	87 103.6 97.3 76.3 155 211.2
(End of boring)		-75 -80					

Color pictures of the cores Yes, attached
Cores will be stored for examination until Const. complete
The "Strength" column represents the uniaxial compressive strength of the core sample (ASTM D-2938)
RQD is the ratio of the total length of sound core specimens >4" to total length of core run

BBS, form 138 (Rev. 8-99)

Illinois Department of Transportation
District Nine Materials
Unconfined Compressive Strength

I - 57
Structure 028-0013/14 (Boring 1-S)
Franklin County



Boring #	Specimen#	Depth	Unconfined Compression
1-S	1	65’ 6”	744 psi
1-S	2	67’ 3”	1,208 psi
1-S	3	68’ 0”	1,439 psi
1-S	4	68’ 6”	1,351 psi
1-S	5	69’ 0”	1,060 psi
1-S	6	69’ 6”	2,153 psi
1-S	7	70’ 0”	2,933 psi

Illinois Department of Transportation
Division of Highways
District 9

SOIL BORING LOG

Page 1 of 2

Date 10/3/19

ROUTE I-57 **DESCRIPTION** Structures over Gun Creek **LOGGED BY** L. Estel

SECTION (28-1)B-2 **LOCATION** Mile Post 78.9 (Median near South Abutments), **SEC.** 7, **TWP.** 5S, **RNG.** 3E, **PM**

COUNTY Franklin **DRILLING METHOD** Hollow stem auger (8" O.D., 3.25" I.D.) **HAMMER TYPE** Auto SPT 140 lbs

STRUCT. NO. 028-0013 & 028-0014
Station 102+70

BORING NO. 2-S
Station 103+75
Offset 14.0ft RT of Med. Alignment
Ground Surface Elev. 417.0 ft

Surface Water Elev. 405.2 ft
Stream Bed Elev. 390.1 ft

Groundwater Elev.:
▽ **First Encounter** 399.0 ft
▼ **Upon Completion** ft
▼ **After** Hrs. ft

	DEPTH (ft)	BLOWS	UCS Qu (tsf)	MOIST (%)
Soft Brown, Dry to Moist SILTY LOAM		5 10 8	 0.5 P	 6
	-5	2 2 3	 0.5 P	 10
411.00				
V. Soft Brown, Dry to Moist SILTY LOAM		2 5 7	 0.1 S	 16
408.50				
Stiff Brown, Moist SILTY CLAY LOAM	-10	5 5 4	 1.8 S	 19
406.00				
Stiff Brown and mottled Grey with specks of Brown, Moist SILTY CLAY LOAM		1 3 4	 1.6 B	 22
403.50				
Stiff Grey, Moist SILTY CLAY	-15	2 4 4	 1.8 B	 24
401.00				
M. Stiff Grey, Moist SILTY LOAM PI = 8, LL = 29, 6% SAND, 80% SILT, and 14% CLAY (Est. based on Lab 54) ▽		2 7 6	 0.5 S	 15
398.50				
Stiff Grey, Moist CLAY LOAM PI > 12 (Est. based on visual ID and historical data)	-20	1 3 4	 1.8 B	 20

	DEPTH (ft)	BLOWS	UCS Qu (tsf)	MOIST (%)
396.00				
M. Stiff Grey, Moist SILTY CLAY LOAM with ORGANICS PI > 12 (Est. based on visual ID and historical data)		1 5 5	 0.8 S	 25
393.50				
Soft Grey, V. Moist SILTY LOAM PI = 8, LL = 29, 6% SAND, 80% SILT, and 14% CLAY (Lab 54)	-25	WOH WOH WOH	 0.3 E	 27
Grey and Brown		WOH WOH WOH	 0.1 B	 29
388.50				
Stiff Brown and Grey with specks of Red, Moist SILTY CLAY LOAM PI > 12 (Est. based on visual ID and historical data)	-30	1 2 3	 1.4 B	 25
386.00				
M. Stiff Brown and Grey with specks of Red, Moist SILTY CLAY LOAM PI > 12 (Est. based on visual ID and historical data)		1 3 3	 0.8 B	 25
	-35	1 2 4	 1.0 B	 26
381.00				
Stiff Brown and Grey with specks of Red, Moist SILTY CLAY PI > 12 (Est. based on visual ID and historical data)		1 2 4	 1.9 B	 25
378.50				
Stiff Grey, Moist CLAY PI > 12 (Est. based on visual ID and historical data)	-40	1 3 3	 1.8 B	 27

The Unconfined Compressive Strength (UCS) Failure Mode is indicated by (B-Bulge, S-Shear, P-Penetrometer, E-Estimated)
Abbreviations W.O.H - Sampler Advanced By Weight of Hammer, W.O.P - Advanced by Weight of Pipe, B.S. - Before Seating
The SPT (N value) is the sum of the last two blow values in each sampling zone (AASHTO T206) BBS, from 137 (Rev. 8-99)

File Name S:\MATERIALS GEOTECHNICAL UNIT\BORING LOGS USING GINT\STATE STRUCTURES\FRANKLIN\028.0013 & 14 I57 OVER GUN CREEK 2019.GPJ Data Template D6TEMPLT.GDT Date Printed 11/19/19
Latitude 38.099947 Longitude -88.911814 Datum NAD83 Job Number

Illinois Department of Transportation
Division of Highways
District 9

SOIL BORING LOG

Page 2 **of** 2

Date 10/3/19

ROUTE I-57 **DESCRIPTION** Structures over Gun Creek **LOGGED BY** L. Estel

SECTION (28-1)B-2 **LOCATION** Mile Post 78.9 (Median near South Abutments), **SEC.** 7, **TWP.** 5S, **RNG.** 3E, **PM**

COUNTY Franklin **DRILLING METHOD** Hollow stem auger (8" O.D., 3.25" I.D.) **HAMMER TYPE** Auto SPT 140 lbs

STRUCT. NO. 028-0013 & 028-0014
Station 102+70

BORING NO. 2-S
Station 103+75
Offset 14.0ft RT of Med. Alignment
Ground Surface Elev. 417.0 **ft**

Surface Water Elev. 405.2 **ft**
Stream Bed Elev. 390.1 **ft**

Groundwater Elev.:
▽ **First Encounter** 399.0 **ft**
▼ **Upon Completion** ______ **ft**
▼ **After** ______ **Hrs.** ______ **ft**

		DEPTH (ft)	BLOWS	UCS Qu (tsf)	MOIST (%)
Stiff Grey, Moist CLAY PI > 12 (Est. based on visual ID and historical data) *(continued)*	373.00				
M. Stiff Grey, Moist SILTY CLAY LOAM PI > 12 (Est. based on visual ID and historical data)	368.00	-45	WOH WOH WOH	0.6 S	28
Stiff Grey, Moist SILTY CLAY LOAM PI > 12 (Est. based on visual ID and historical data)	363.00	-50	2 5 7	1.9 B	20
Hard Brown, Dry weathered SANDSTONE		-55 -60	100/4"		

	DEPTH (ft)	BLOWS	UCS Qu (tsf)	MOIST (%)
Bottom of hole at 54.3 ft Elevation referenced to BM 8, Sawed Square at NW Corner of SN 028-0013; EL. 417.62 To convert "N" values to "N60", multiply by 1.5	-65			
	-70			
	-75			
	-80			

The Unconfined Compressive Strength (UCS) Failure Mode is indicated by (B-Bulge, S-Shear, P-Penetrometer, E-Estimated)
Abbreviations W.O.H - Sampler Advanced By Weight of Hammer, W.O.P - Advanced by Weight of Pipe, B.S. - Before Seating
The SPT (N value) is the sum of the last two blow values in each sampling zone (AASHTO T206) BBS, from 137 (Rev. 8-99)

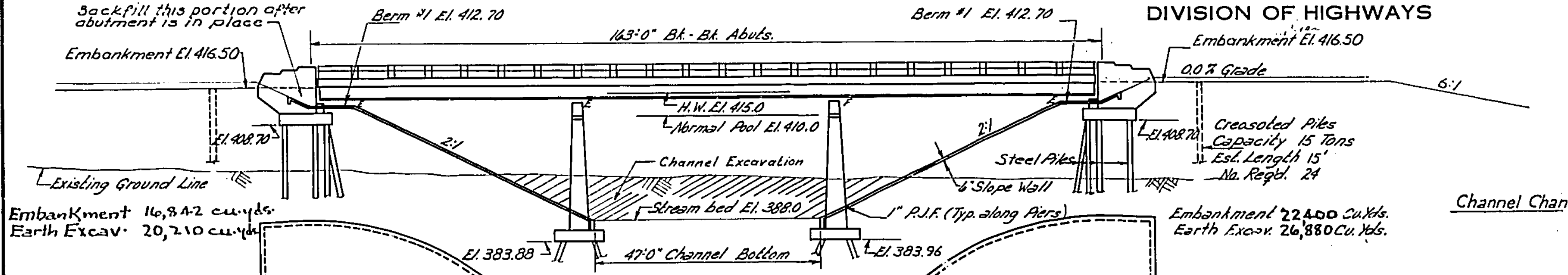
File Name S:\MATERIALS GEOTECHNICAL UNIT\BORING LOGS USING GINT\STATE STRUCTURES\FRANKLIN\028.0013 & 14 I57 OVER GUN CREEK 2019.GPJ Data Template D6TEMPLT.GDT Date Printed 11/19/19
Latitude 38.099947 Longitude -88.911814 Datum NAD83 Job Number

ROUTE NO.	SECTION	COUNTY	TOTAL SHEETS	SHEET NO.
S.B.I. F.A.I. 57	28-1B 28-1F	Franklin	29 9	7 6
FED. ROAD DIST. NO. 1	ILLINOIS	FED. AID PROJECT: I-57-2 (33)77		

SHEET NO. 1
10 SHEETS

STATE OF ILLINOIS
DEPARTMENT OF PUBLIC WORKS & BUILDINGS
DIVISION OF HIGHWAYS

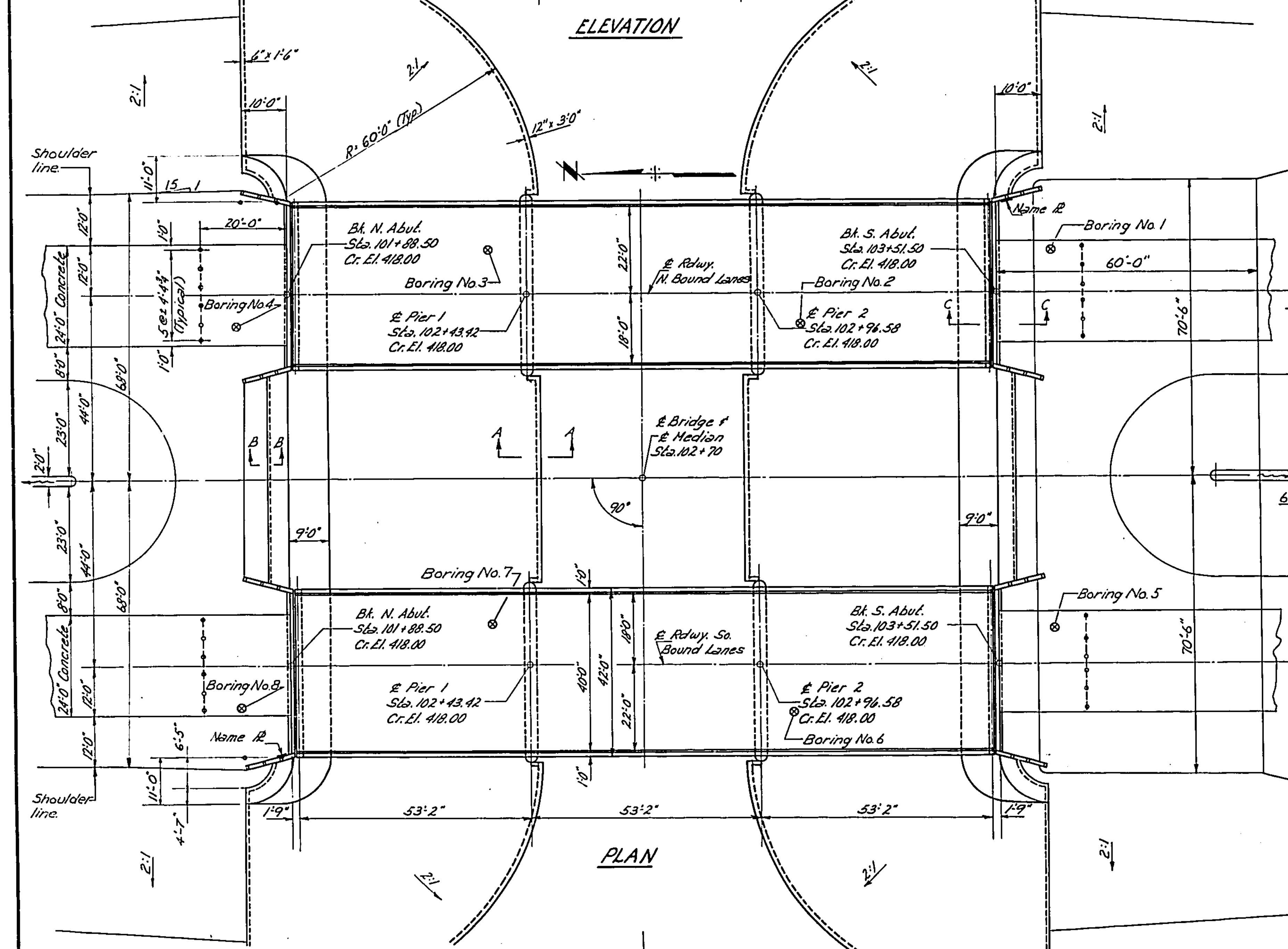
B.M. Concrete Monument 150' Rt.
Sta. 102+50 Elev. 399.52



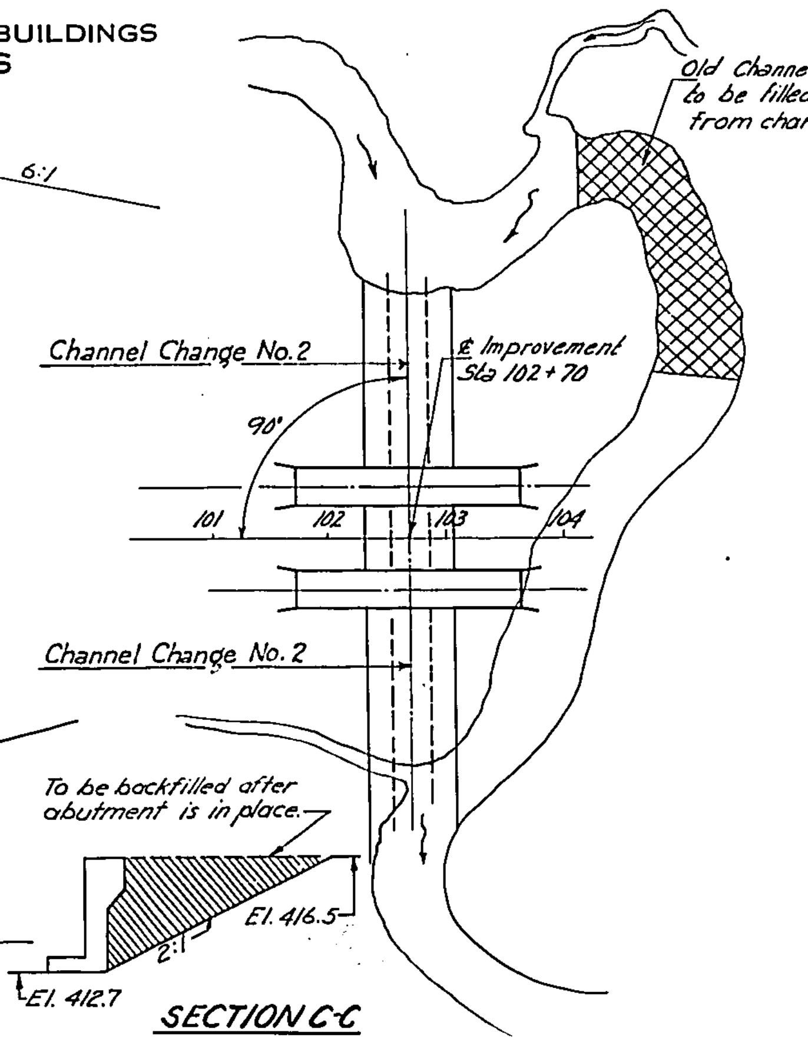
Embankment 16,842 cu.yds.
Earth Excav. 20,210 cu.yds.

Embankment 22400 Cu.Yds.
Earth Excav. 26,880 Cu.Yds.

ELEVATION



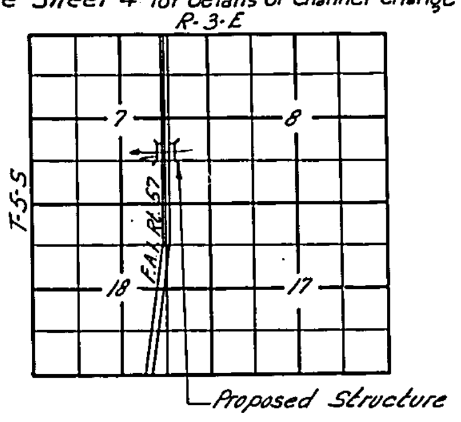
PLAN



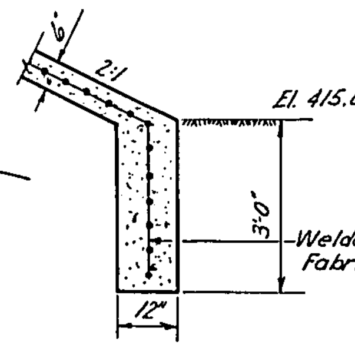
SECTION C-C

SKETCH OF CHANNEL CHANGE NO. 2

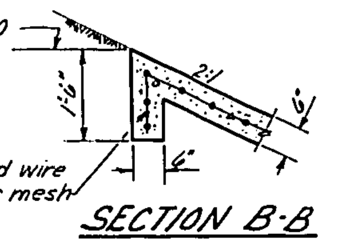
(Channel Excavation = 12,545 Cu.Yds.)
[See Sheet 4 for details of Channel Change No. 1]



LOCATION SKETCH



SECTION A-A



SECTION B-B

GENERAL NOTES

Class X Concrete shall be used throughout except in piers.

Class A Concrete shall be used in piers.

Coarse aggregate which is to be used in end posts must be absolutely free of chert, flint, limonite, lignite and soft sandstone.

The concrete floor slab shall be finished in accordance with Article 51.19 of the Standard Specifications.

Slope Wall shall be reinforced with welded wire fabric, 6"x6" mesh, #4 wires, weighing 58# per 100 sq.ft.

Layout of slope walls may be varied to suit ground conditions in the field as directed by the Engineer.

Rivets ⅞"ϕ, open holes 15/16"ϕ, unless noted.

All Structural Steel shall conform to A.S.T.M. A-36 Specifications for Structural Steel.

Anchor bolts shall be set before riveting diaphragms over supports.

All bolsters, rockers, bearing plates, lead plates, shim plates, pintles and anchor bolts shall be fabricated and set in accordance with Article 51.15 of the Standard Specifications and are included in quantity of Structural Steel.

Roadway expansion guards shall be fabricated and erected in accordance with Article 51.13(d) of the Standard Specifications and are included in quantity of Structural Steel.

Exposed surface of expansion guard angles shall be given two shop coats of red lead paint.

Except as otherwise provided all structural steel shall receive one shop coat of red lead paint and two field coats of aluminum paint. See Articles 56.1 to 56.5 inclusive of the Standard Specifications.

All paint shall be furnished and applied by the contractor.

The Contractor shall drive one each steel test pile at the N. Abut. and Pier 2 of the E. bridge, S. Abut. and Pier 1 of the W. bridge, all in permanent locations, as directed by the Engineer before ordering the remaining piles.

WATERWAY INFORMATION

Drainage Area----------------26,610 Acres
Character------------------Level
Proposed Opening (50 yr. fl.)------986 Sq. Ft. below El. 402.0

TOTAL BILL OF MATERIAL

Item		Super	Sub	Sec. 28-1F	Sec. 28-1B
Class "A" Excav. for Struct.	Cu. Yd.		540		*1360
Class A Concrete	Cu. Yd.		598.0		598.0
Class X Concrete	Cu. Yd.	334.6	178.8		513.4
Furnishing Structural Steel	Lbs.			333,660	
Erecting Structural Steel	Lbs.				333,660
Furn. & Erect. Metal Handrail	Lin. Ft.	642			642
Reinforcement Bars	Lbs.	86,470	34,700		121,170
Creosoted Piles	Lin. Ft.				360
Steel Piles (8BP36)	Lin. Ft.		4,760		4,760
Test Piles (8BP36)	Ea.		4		4
Name ℗'s	Ea.	2			2
Slope Wall (6")	Sq. Yd.		3,930		3,930
Protective Coat	Sq. Yd.				1,635

* Including Excav. for slope wall = 820 Cu. Yd.

DESIGNED	Wm. H. McKinney, Jr.
CHECKED	T. M. Yang
DRAWN	P. Lawler W.N.M.
CHECKED	T. M. Yang

Nov. 14 1961
EXAMINED W. E. Baumann
ENGINEER OF BRIDGE AND TRAFFIC STRUCTURES
PASSED E. L. Strauch
ENGINEER OF DESIGN
APPROVED R. R. Bartelsmeyer
CHIEF HIGHWAY ENGINEER

FLOW

DESIGN STRESSES

f_c = 1,400 p.s.i. Super & Sub
v_c = 75 p.s.i. Footings
f_s = 20,000 p.s.i. Reinf.
f_s = 20,000 p.s.i. Struct. (A-36)
n = 10

LOADING H20-S16-44 & ALT.

STA. 102+70
BUILT 196 BY
STATE OF ILLINOIS
F.A.I. RT. 57 SEC. 28-1B
F.A. PROJ. I-57-2 (33)
LOADING H20-S16 & ALT.

NAME PLATE

See Std. 2113

GENERAL PLAN & ELEVATION
PROJ. I-57-2 (33)77
GUN CREEK
F.A.I. RT. 57 SEC. 28-1B-F
FRANKLIN COUNTY
STA. 102+70

Revised 12-29-61-WJM At location of So. Abut. in ELEVATION, and in TOTAL BILL OF MATERIAL, changed designation of Borrow Exc. to Earth Exc. Changed title of channel change sketch to indicate that it covered Channel Change No. 2 only, & added note that details of Channel Change No. 1 were to be found on Sheet 4 of the contract plans; in the channel change sketch, & in TOTAL BILL OF MATERIAL, changed quantity of Channel Exc. from 9,943 to 12,545 Cu. Yds.

Revised 5/22/62 Quantity of Reinf. Bars chgd. from 81,180 to 86,470 (Super) & from 115,880 to 121,170 (Total) Added item Protective Coat. R.A.2.

K-E

STATE OF ILLINOIS
DEPARTMENT OF PUBLIC WORKS & BUILDINGS
DIVISION OF HIGHWAYS

I-57	28-1B	Franklin	29	15

SHEET NO. 9
10 SHEETS

ROUTE F.A.I. 57
SEC. 28-1B
COUNTY Franklin
over Gunn Creek
STA. 102+70
Bored By J. Congiardo
Checked By W. E. Stallman

Boring No. 1
Station 103+65M
Offset 55' Lt.

	Elevation	N	Qu t/s.f.	w (%)
Ground Surface	397.5 0			
Medium soft and moist brown silty clay loam A-4(8-9)				
		Auger Sample		22
Medium and moist tan mottled grey silty clay loam to silty loam A-4(8)	393.0 -5			
		7	1.7P	21
		11	1.4S	20
Medium and moist grey mottled brown silty clay loam A-4(8)	388.0 -10			
		8	1.0S	23
Medium soft and moist brown mottled grey silty clay A-6(10)	385.0			
		8	0.9S	22
	-15			
		6	0.9S	22
Medium stiff and moist brown mottled grey clay A-7-6(12-14)	381.0			
		9	1.6S	24
	-20			
		9	1.4S	23

Surface Water El. —
Groundwater El. at Completion 387.4
After 24 Hours 392.4

	Elevation	N	Qu t/s.f.	w (%)
(See previous column)				
		8	2.1B	22
Medium stiff and moist grey silty clay A-6(10-11)	373.5 -25			
		5	0.9S	32
		9	1.7S	30
	-30			
		9	1.9S	32
Medium and very moist grey clay loam A-6(9-10)	365.5			
		9	1.6S	39
Loose and wet medium graded fine grey sand	363.5 -35			
		14	-	27
		12	Lost Sample	
Dense and very moist medium graded brown and grey sand and gravel.	357.5 -40			
		100 Blows in 9 inches		
(See next sheet)	355.5			
		100 Blows in 5 inches		
	-45			

COUNTY Franklin
Boring No. 1
Station 103+65M
Offset 55' Lt.

	Elevation	N	Qu t/s.f.	w (%)
~~Ground Surface~~	40			
(see previous sheet)				
		100 Blows in 9 inches		
Medium and dry coarse grained brown to grey sandstone	355.5			
		100 Blows in 5 inches		
	45			
		Cored with 95% Recovery		
	50			
Bottom of Hole = 50.5 feet	347.0			
	55			
	60			

During drilling operation, it appeared that free water was encountered at 15 feet.

Hole was washed out to obtain samples from 36.0 to 42.0 feet. Hole was cored from 44.5 feet to 50.5 feet.

COUNTY Franklin
Boring No. 3
Station 102+34M
Offset 55' Lt.

	Elevation	N	Qu t/s.f.	w (%)
Ground Surface	398.7 0			
Medium and moist brown silty clay loam to silty loam A-4(8)				
		Auger Sample		13
	-5			
Medium and moist grey silty loam to silty clay loam A-4(8)	391.2			
		19	1.2S	15
		10	1.0S	21
Medium and moist grey mottled brown silty clay A-6(9-11)	389.2 -10			
		8	1.0S	23
		4	0.5B	28
	-15			
		6	1.1B	24
Stiff and moist grey mottled brown clay A-7-6(13-15)	381.7			
		8	1.7S	28
	-20			
		7	1.6S	26

Surface Water El. —
Groundwater El. at Completion 386.6
After 24 Hours 390.6

	Elevation	N	Qu t/s.f.	w (%)
(See previous column)				
		7	1.7S	27
Medium stiff and moist grey clay A-6(12-13)	374.2 -25			
		6	1.5S	30
		8	1.2S	27
Medium stiff and very moist grey sandy clay loam	368.7 -30			
		15	2.0P	15
		12	1.5P	21
Loose and wet fine graded grey sand	363.7 -35			
		5	-	18
Medium and moist grey clay loam A-6(7-8)	361.2			
		21	1.5P	17
Medium dense and wet coarse graded grey sand and gravel	359.2 -40			
		62	-	14
(see next sheet)	356.2			
		100 Blows in 5 inches		
	-45			

COUNTY Franklin
Boring No. 3
Station 102+34M
Offset 55' Lt.

	Elevation	N	Qu t/s.f.	w (%)
~~Ground Surface~~	40			
(See previous sheet)				
		62	-	14
Soft and moist coarse grained grey sandstone	356.2			
		100 Blows in 5 inches		
	45			
		Cored with 95% Recovery		
	50			
Bottom of Hole = 51.0 feet	347.7			
	55			
	60			

During drilling operation, it appeared that free water was encountered at 12.0 feet.

Hole was washed out to obtain samples from 36.5 feet to 40.0 feet. Hole was cored from 45.0 feet to 51.0 feet.

Notes:

N - Standard Penetration Test - Blows per foot to drive 2" O.D. Split Spoon Sampler 12" with 140 lb hammer falling 30".

Qu - Unconfined Compressive Strength - t/sf

w - Water Content - percentage of oven dry weight - %.

Type failure:
B - Bulge Failure
S - Shear Failure
E - Estimated Value
P - PENETROMETER VALUE

COUNTY Franklin
Boring No. 2
Station 103+06M
Offset 35' Lt.

	Elevation	N	Qu t/s.f.	w (%)
Ground Surface	397.6 0			
Medium soft and moist brown silty clay loam A-4(8-9)				
		Auger Sample		17
Medium and moist tan mottled grey silty clay loam to silty loam A-4(8)	393.1 -5			
		16	1.8P	15
		12	1.2S	16
Medium soft and very moist tan mottled grey silty clay A-6(10-11)	388.6 -10			
		7	0.5S	21
		5	0.4S	20
Medium and moist tan mottled grey clay A-6(11-12)	383.6 -15			
		5	1.1B	19
		7	1.3S	29
Medium and moist tan mottled grey clay A-7-6(12-14)	378.6 -20			
		7	1.2B	25
(See next column)	375.6			

Surface Water El. —
Groundwater El. at Completion 386.7
After 24 Hours 391.7

	Elevation	N	Qu t/s.f.	w (%)
Medium stiff and moist grey silty clay A-6(10-11)				
		7	1.9S	28
	-25			
		6	1.2S	29
Medium stiff and moist dark grey silty clay A-6(10-11) with some rotten vegetation included	369.6			
		7	0.8B 1.7P	25 29
Medium and very moist dark grey silty clay A-6(9-10)	367.6 -30			
		8	1.5S	35
		5	1.1S	39
Loose to medium and wet medium graded medium grained sand	362.1 -35			
		13	1.1S -	28 20
		20	-	20
Medium dense and wet coarse graded grey sand and gravel	357.6 -40			
		45	-	15
(see next sheet	355.6			
		100 Blows in 5 inches		
	-45			

COUNTY Franklin
Boring No. 2
Station 103+06M
Offset 35' Lt.

	Elevation	N	Qu t/s.f.	w (%)
~~Ground Surface~~	40			
(See previous sheet)				
		45	-	15
Soft and moist coarse grained brown to grey sandstone	355.6			
		100 Blows in 5 inches		
	45			
		Cored with 70% Recovery		
	50			
Bottom of Hole = 50.5 feet	347.1			
	55			
	60			

During drilling operation, it appeared that free water was encountered at 15 feet.

Hole was washed out to obtain samples from 36.0 to 42.0 feet. Hole was cored from 44.5 feet to 50.5 feet with 70% recovery. Most of loss was between 48.5 and 50.5 feet. Poor recovery is attributed to fact that a piece of core was lodged in core barrel in such a way to break up and grind away part of core.

BRIDGE FOUNDATION BORING LOG

PROJECT —
ROUTE F.A.I. 57
SEC. 28-1B
COUNTY Franklin
BRIDGE carrying Interstate over Gunn Creek
STA. 102+70
Date September 1961
Bored By J. Congiardo
Checked By W. E. Stallman

Boring No. 4
Station 101+76M
Offset 35' Lt.

	Elevation	N	Qu t/s.f.	w (%)
Ground Surface	398.4 0			
Medium and moist brown silty clay loam A-4(8)				
		Auger Sample		23
Medium and moist to very moist brown mottled grey to grey silty clay A-6(9-10)	394.4 -5			
		7	1.4S	27
		6	1.1B	26
	-10			
		4	0.5P	26
		4	0.8B	22
	-15			
		5	0.9S	25
Stiff and moist grey mottled brown clay A-7-6(13-14)	381.9			
		7	1.1S	28
	-20			
		7	2.2B	44

Surface Water El. —
Groundwater El. at Completion 388.5
After 24 Hours 389.5

	Elevation	N	Qu t/s.f.	w (%)
(See previous column)				
		10	2.0B	24
Soft to medium and very moist grey clay loam A-6(9-10)	374.4 -25			
		4	0.7S	24
		8	1.2S	27
Medium and moist grey sandy loam	369.4 -30			
Loose and wet medium graded fine to medium coarse grey sand	367.9			
		16	1.5P -	8 20
		2	-	19
	-35			
		28	-	18
Stiff and moist grey sandy clay loam	361.9			
		14	2.7P	17
Medium dense and wet coarse graded grey sand with some gravel	359.4 -40			
		65	-	20
(See next sheet)	356.4			
		100 Blows in 5 inches		
	-45			

BRIDGE FOUNDATION BORING LOG

PROJECT —
ROUTE F.A.I. 57
SEC. 28-1B
COUNTY Franklin
BRIDGE carrying Interstate over Gunn Creek
STA. 102+70
Date September 1961
Bored By J. Congiardo
Checked By W. E. Stallman

Boring No. 4
Station 101+76M
Offset 35' Lt.

	Elevation	N	Qu t/s.f.	w (%)
~~Ground Surface~~	40			
(See previous sheet)				
		65	-	20
Soft and moist coarse grained grey sandstone	356.4			
		100 Blows in 5 inches		
	45	100 Blows in 4 inches		
		100 Blows in 4 inches		
Bottom of Hole = 50.0 feet	348.4 50	100 Blows in 6 inches		
	55			
	60			

During drilling operation, it appeared that free water was encountered at 12 feet.

Hole was washed out to obtain samples from 31.0 to 42.0 feet. No coring operation was used in this hole.

DESIGNED
CHECKED T. M. Yang
DRAWN L. Wanless
CHECKED T. M. Yang

Nov. 14 1961
EXAMINED W.E. Baumann
ENGINEER OF BRIDGE AND TRAFFIC STRUCTURES
PASSED
ENGINEER OF DESIGN
APPROVED R.R. Bartelsmeyer
CHIEF HIGHWAY ENGINEER

BORING DATA
F.A.I. RT. 57 SEC. 28-1B
FRANKLIN COUNTY
STA. 102+70

F.A.I. RT.	SECTION	COUNTY	TOTAL SHEETS	SHEET NO.
I.57	28-1B	Franklin	29	16

SHEET NO. 10
10 SHEETS

STATE OF ILLINOIS
DEPARTMENT OF PUBLIC WORKS & BUILDINGS
DIVISION OF HIGHWAYS
BRIDGE FOUNDATION BORING LOG

PROJECT —
ROUTE F.A.I. 57
SEC. 28-1B
COUNTY Franklin
BRIDGE carrying Interstate over Ounn Creek
STA. 102+70
Date September 1961
Bored By J. Congiardo
Checked By W. E. Stallman

COUNTY Franklin
Boring No. 5
Station 103+65M
Offset 35' Rt.
Surface Water El. —
Groundwater El. at Completion 389.0
After 100 Hours 392.0

Ground Surface 398.0

Medium and moist brown silty clay loam A-4(8)

389.0
Soft and moist brown mottled grey silty clay A-6(10-11)

385.5
Medium stiff and moist brown mottled grey silty clay to silty clay loam A-6(9-10)

381.5
Stiff and moist grey mottled brown silty clay to clay A-7-6(12-14)

376.5
(See next column)

N	Qu t/s.f.	w (%)
Auger Sample		23
5	0.6S	26
4	0.6P	26
2	0.5P	29
8	1.3S	22
6	1.0S	26
6	1.6B	25
9	1.7S	27

Medium stiff and moist dark grey silty clay A-6(10-11) with some rotten vegetation included

371.5
Stiff and moist grey sandy clay to clay loam

370.0
Medium dense and moist fine grained grey sand

368.5
Soft to medium and moist fine to medium grained grey and brown sandstone

357.5
Bottom of Hole = 40.5 feet
During drilling operation, it appeared that free water was encountered at 13.0 feet.
Except for coring operation, entire hole was augered to obtain samples.

N	Qu t/s.f.	w (%)
4	1.1	46
4	1.0B	32
65	1.0S –	21 17
100 Blows in 6 inches		
100 Blows in 3 inches		
Cored with 90% Recovery		

COUNTY Franklin
Boring No. 7
Station 102+34M
Offset 35' Rt.
Surface Water El. —
Groundwater El. at Completion 388.0
After 24 Hours 389.0

Ground Surface 398.1

Medium and moist brown silty clay loam A-4(8)

391.6
Medium and moist brown to brown mottled grey silty clay A-6(12)

384.1
Medium and moist grey mottled brown silty clay to silty clay loam A-6(9-10)

379.1
Medium stiff and moist grey clay A-7-6(13-15)

N	Qu t/s.f.	w (%)
Auger Sample		15
12	0.6S	23
10	1.2S	28
5	0.8B	27
4	1.1B	27
5	1.0S	24
3	0.5B	28
6	0.8S	28

(see previous column)

374.1
Medium stiff and moist dark grey silty clay A-6(10-11)

369.1
Stiff and moist dark grey clay loam A-6(8)

364.1
Loose to medium and wet fine graded grey sand

358.1
Dense and wet coarse graded grey sand with gravel

356.1
(see next sheet)

N	Qu t/s.f.	w (%)
8	1.9B	20
6	1.3S	24
5	1.2S	28
16	2.6S	24
7	1.6S	20
15	–	24
7	–	26
22	–	16
100 Blows in 10 inches		

COUNTY Franklin
Boring No. 7
Station 102+34M
Offset 35' Rt.

(see previous sheet)

356.1
Soft to medium and moist medium grained grey sandstone

347.6
Bottom of Hole = 50.5 feet
During drilling operation, it appeared that free water was encountered at 15.0 feet.
Hole was washed to obtain samples from 36.0 feet to 42.0 feet. Hole was cored from 44.5 feet to 50.5 feet.

N	Qu t/s.f.	w (%)
22	–	16
100 Blows in 10 inches		
cored with 85% Recovery		

COUNTY Franklin
Boring No. 6
Station 103+06M
Offset 55' Rt.
Surface Water El. —
Groundwater El. at Completion 386.5
After 24 Hours 390.5

Ground Surface 396.5

Medium and moist brown mottled grey silty clay loam A-4(8-9)

386.5
Medium soft and very moist grey silty clay A-6(10)

382.5
Medium stiff and moist grey mottled brown silty clay to clay A-6(12-13)

375.0
(See next column)

N	Qu t/s.f.	w (%)
Auger Sample		34
4	0.6P	30
4	0.7S	27
2	0.7P	25
2	0.7P	45
7	1.7S	24
7	1.5B	26
5	0.9S	23

Medium and moist grey silty clay to clay loam A-6(9)

369.0
Medium stiff and moist dark grey silty clay A-6(10-11)

361.0
Dense and moist medium graded grey sand – near a soft sandstone

356.5
(See next sheet)

N	Qu t/s.f.	w (%)
3	0.6 S	24
4	1.0B	27
5	1.0S	27
5	1.1S	46
7	1.6S	26
16	1.3S 1.5P	25 17
12	–	48
100 Blows in 2 inches		
100 Blows in 3 inches		

BRIDGE FOUNDATION BORING LOG

PROJECT —
ROUTE F.A.I. 57
SEC. 28-1B
COUNTY Franklin
BRIDGE carrying Interstate over Ounn Creek
STA. 102+70
Date September 1961
Bored By J. Congiardo
Checked By W. E. Stallman

Boring No. 6
Station 103+06M
Offset 55' Rt.
Surface Water El. —
Groundwater El. at Completion 386.5
After 24 Hours 390.5

Medium hard and moist medium grained grey to brown sandstone

346.0
Bottom of Hole = 50.5 feet
During drilling operation, it appeared that free water was encountered at 15.0 feet.
Hole was washed out to obtain samples from 38.5 feet to 42.0 feet. Hole was cored from 44.5 feet to 50.5 feet.

N	Qu t/s.f.	w (%)
100 Blows in 2 inches		
100 Blows in 3 inches		
Cored with 75% Recovery		

COUNTY Franklin
Boring No. 8
Station 101+76M
Offset 55' Rt
Surface Water El. None
Groundwater El. at Completion 387.0
After 24 Hours 389.5

Ground Surface 398.1

Medium and moist brown silty clay loam A-4(8)

393.1
Stiff and moist brown mottled grey silty clay A-6(10-12)

386.6
Medium and moist grey mottled brown silty clay A-6(10-11)

381.6
Medium and moist brown mottled grey clay loam A-6(9-10)

378.6
(See next column)

N	Qu t/s.f.	w (%)
Augered Sample		13
10	2.2S	23
7	1.2S	23
5	1.1S	26
4	0.7B	24
5	0.9B	26
7	0.9S	22
7	1.6B	26

Medium stiff and moist grey mottled brown clay A-6(12-13)

371.6
Medium and moist dark grey clay loam to clay A-6(10-11)

366.6
Medium and very moist dark grey sandy clay loam

361.6
Medium and moist dark grey clay loam A-6(8)

359.1
Medium dense and moist coarse graded grey sand and gravel

356.1
(See next sheet)

N	Qu t/s.f.	w (%)
6	1.3B	25
5	1.2S	26
6	0.9S	25
6	1.2S	27
8	0.8S	18
13	0.9P	21
11	1.2P	21
49	–	15
100 Blows in 2 inches		

COUNTY Franklin
Boring No. 8
Station 101+76M
Offset 55' Rt.

(See previous sheet)

356.1
Medium hard and moist grey medium grained sandstone

346.6
Bottom of Hole = 51.5 feet
During drilling operation, it appeared that free water was encountered at 13.0 feet.
Hole was washed to obtain samples between 36.0 feet and 42.0 feet. Hole was cored from 43.5 feet to 51.5 feet.

N	Qu t/s.f.	w (%)
49	–	15
100 Blows in 2 inches		
Cored with 75% Recovery		

Notes:

N – Standard Penetration Test – Blows per foot to drive 2" O.D. Split Spoon Sampler 12" with 140# hammer falling 30".

Qu – Unconfined Compressive Strength – t/sf

w – Water Content – percentage of oven dry weight-%.

Type failure:
B- Bulge Failure
S- Shear Failure
E- Estimated Value
P-PENETROMETER VALUE

DESIGNED
CHECKED T. M. Yang
DRAWN L. Wanless
CHECKED T. M. Yang

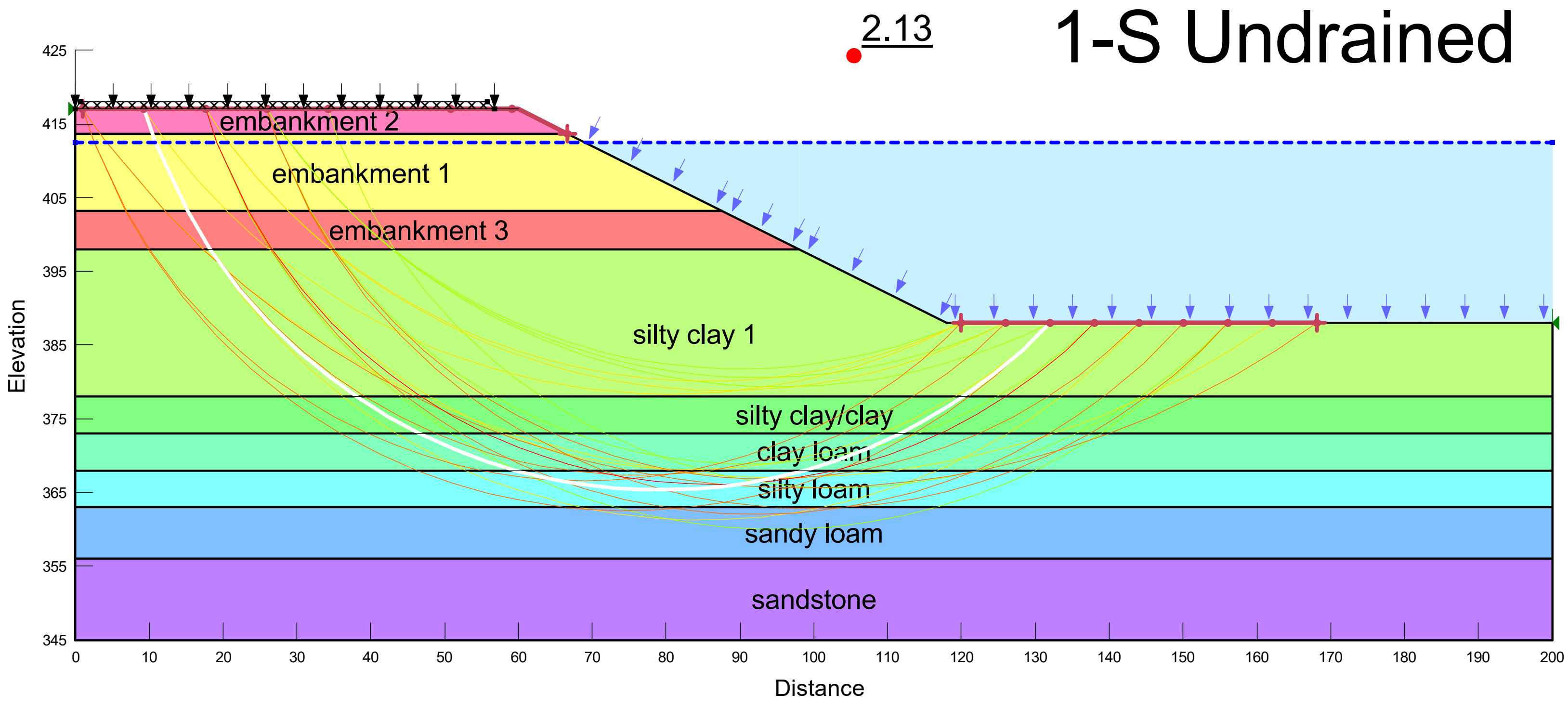
Nov. 14 1961
EXAMINED W. E. Baumann
ENGINEER OF BRIDGE AND TRAFFIC STRUCTURES
PASSED E. F. Sheetz
ENGINEER OF DESIGN
APPROVED R. R. Bartelsmeyer
CHIEF HIGHWAY ENGINEER

BORING DATA
F.A.I. RT. 57 SEC. 28-1B
FRANKLIN COUNTY
STA. 102+70

Appendix C:

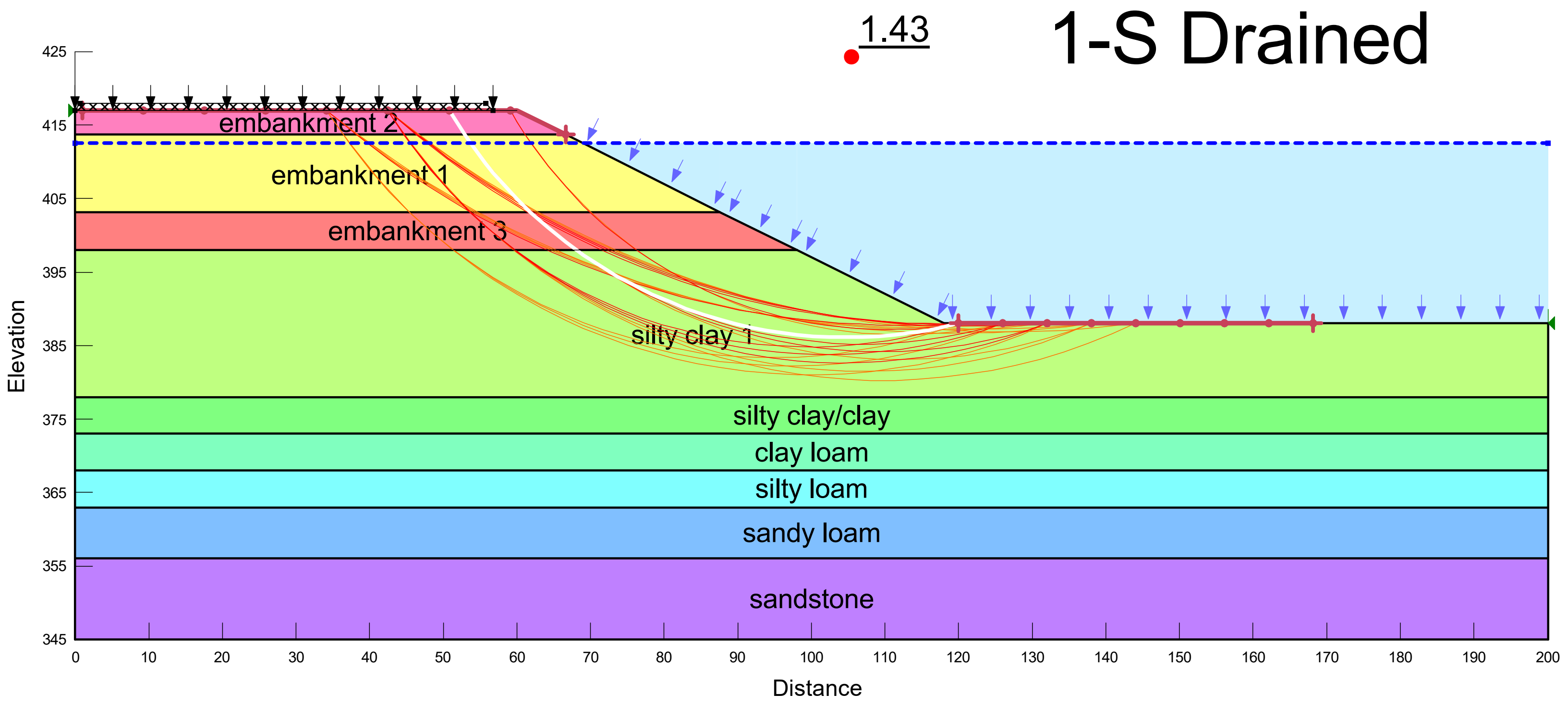
Summary Stability Profiles

Color	Name	Material Model	Unit Weight (pcf)	Effective Cohesion (psf)	Effective Friction Angle (°)	Cohesion (psf)
🟩	clay loam	Undrained (Phi=0)	120			600
🟨	embankment 1	Undrained (Phi=0)	120			250
🟥	embankment 2	Undrained (Phi=0)	120			3,100
🟥	embankment 3	Undrained (Phi=0)	120			1,800
🟪	sandstone	Bedrock (Impenetrable)				
🟦	sandy loam	Mohr-Coulomb	120	0	28	
🟩	silty clay 1	Undrained (Phi=0)	120			750
🟩	silty clay/clay	Undrained (Phi=0)	120			1,600
🟦	silty loam	Undrained (Phi=0)	120			400

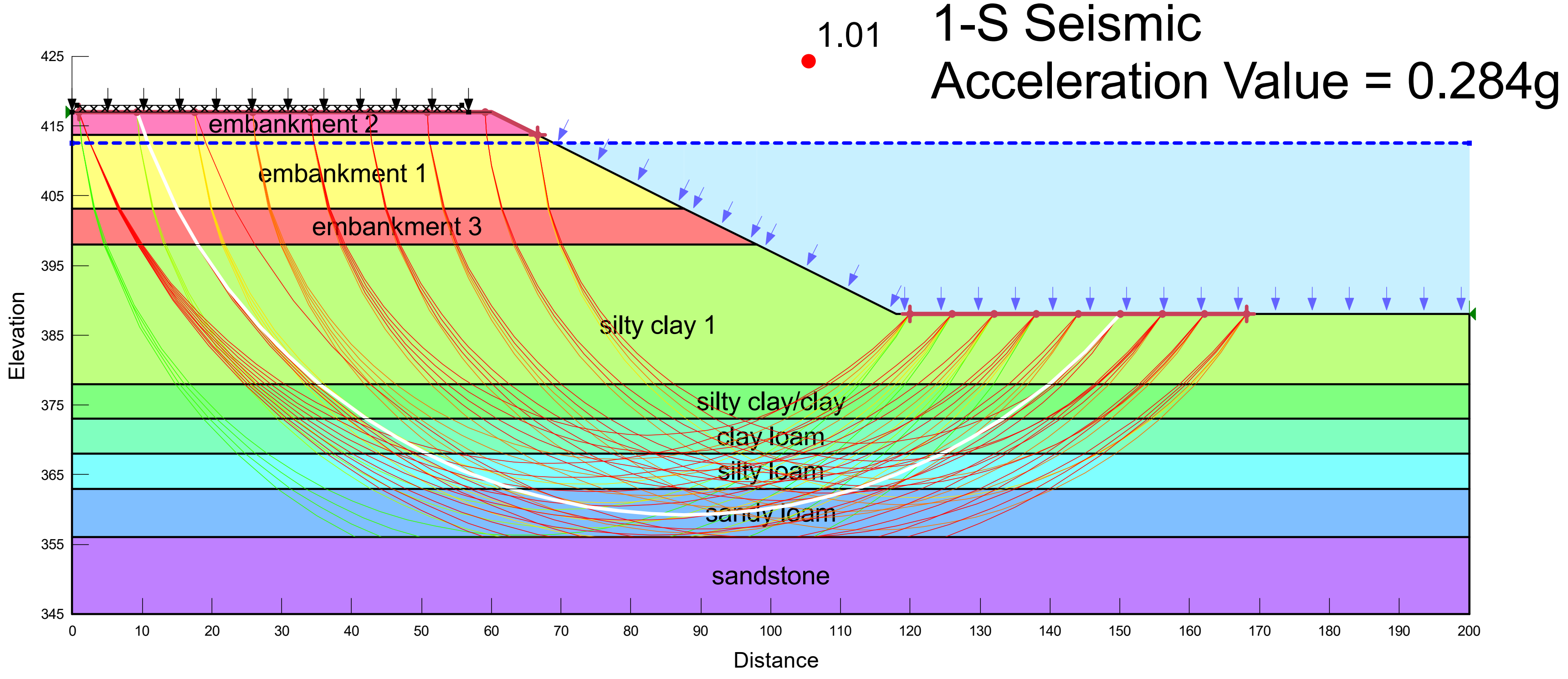


1-S Undrained

Color	Name	Material Model	Unit Weight (pcf)	Effective Cohesion (psf)	Effective Friction Angle (°)	Phi-B (°)
🟩	clay loam	Mohr-Coulomb	120	50	27	0
🟨	embankment 1	Mohr-Coulomb	120	100	26	0
🟪	embankment 2	Mohr-Coulomb	120	50	28	0
🟥	embankment 3	Mohr-Coulomb	120	100	28	0
🟪	sandstone	Bedrock (Impenetrable)				
🟦	sandy loam	Mohr-Coulomb	120	0	30	28
🟩	silty clay 1	Mohr-Coulomb	120	50	26	0
🟩	silty clay/clay	Mohr-Coulomb	120	100	26	0
🟦	silty loam	Mohr-Coulomb	120	50	28	0



Color	Name	Material Model	Unit Weight (pcf)	Effective Cohesion (psf)	Effective Friction Angle (°)	Phi-B (°)
🟩	clay loam	Mohr-Coulomb	120	50	27	0
🟨	embankment 1	Mohr-Coulomb	120	100	26	0
🟪	embankment 2	Mohr-Coulomb	120	50	28	0
🟥	embankment 3	Mohr-Coulomb	120	100	28	0
🟪	sandstone	Bedrock (Impenetrable)				
🟦	sandy loam	Mohr-Coulomb	120	0	30	28
🟩	silty clay 1	Mohr-Coulomb	120	50	26	0
🟩	silty clay/clay	Mohr-Coulomb	120	100	26	0
🟦	silty loam	Mohr-Coulomb	120	50	28	0

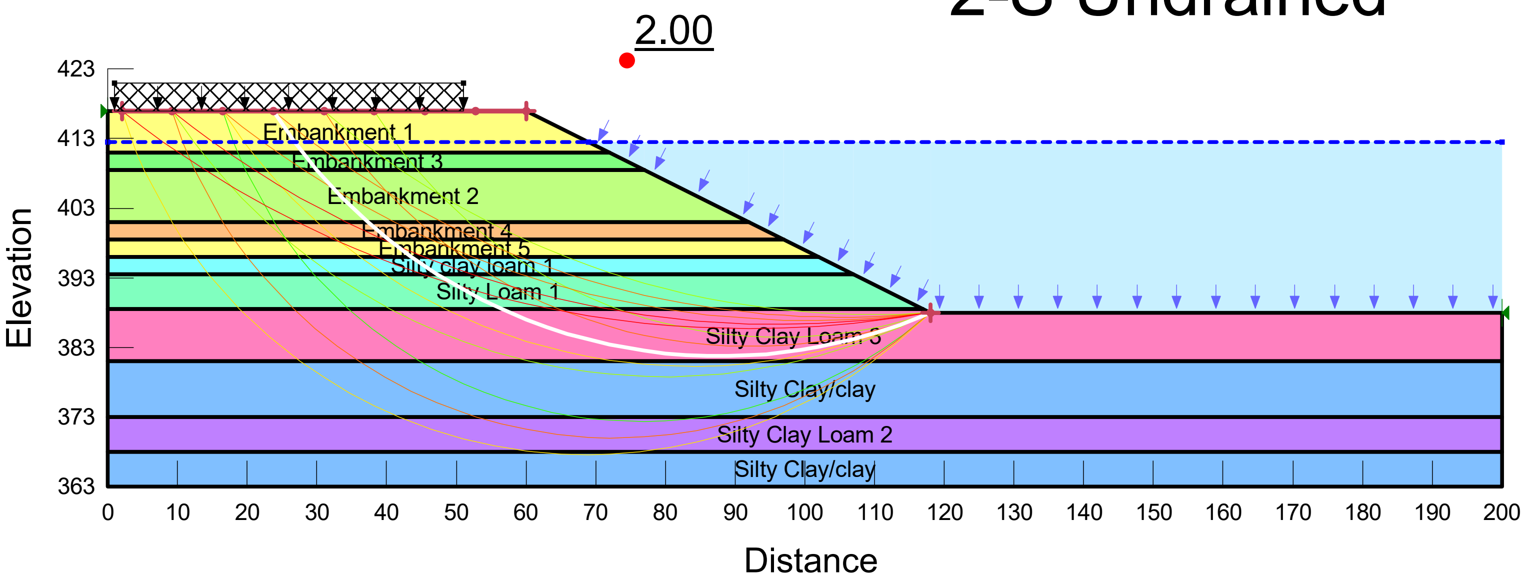


1-S Seismic

Acceleration Value = 0.284g

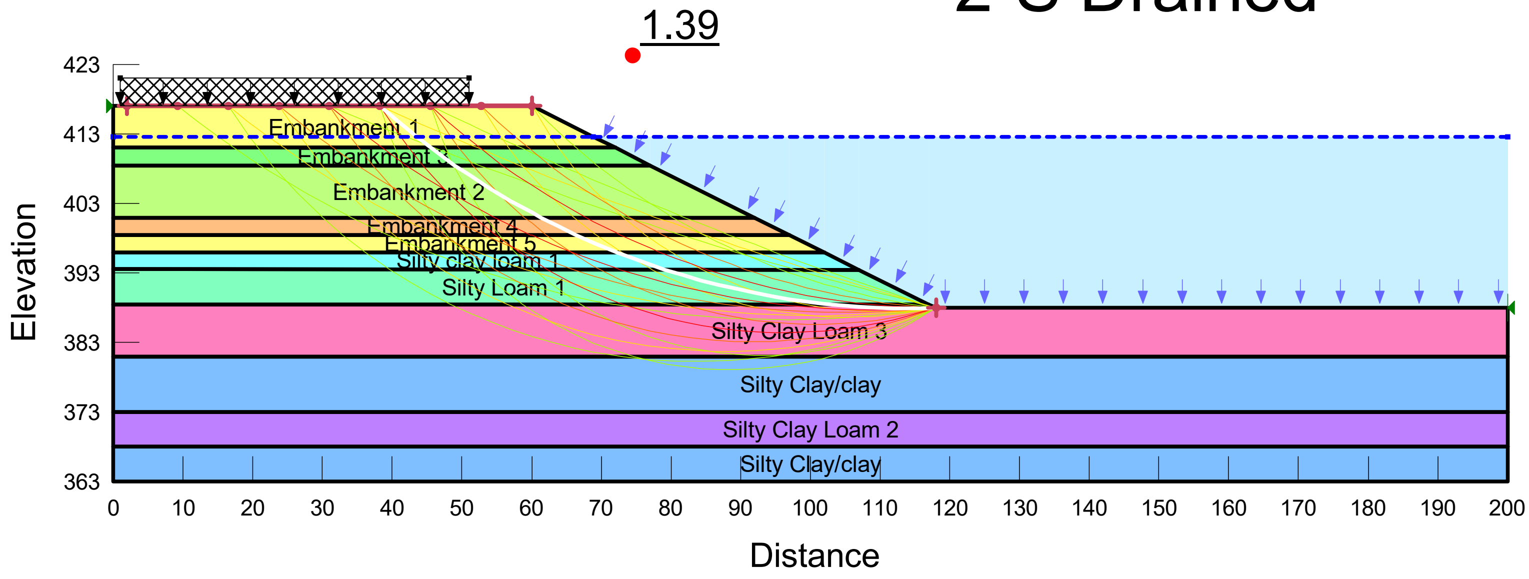
Color	Name	Material Model	Unit Weight (pcf)	Cohesion (psf)
🟨	Embankment 1	Undrained (Phi=0)	120	500
🟩	Embankment 2	Undrained (Phi=0)	120	1,750
🟩	Embankment 3	Undrained (Phi=0)	120	100
🟧	Embankment 4	Undrained (Phi=0)	120	500
🟨	Embankment 5	Undrained (Phi=0)	120	1,800
🟦	Silty clay loam 1	Undrained (Phi=0)	120	800
🟪	Silty Clay Loam 2	Undrained (Phi=0)	120	600
🟥	Silty Clay Loam 3	Undrained (Phi=0)	120	1,000
🟦	Silty Clay/clay	Undrained (Phi=0)	120	1,800
🟩	Silty Loam 1	Undrained (Phi=0)	120	200

2-S Undrained



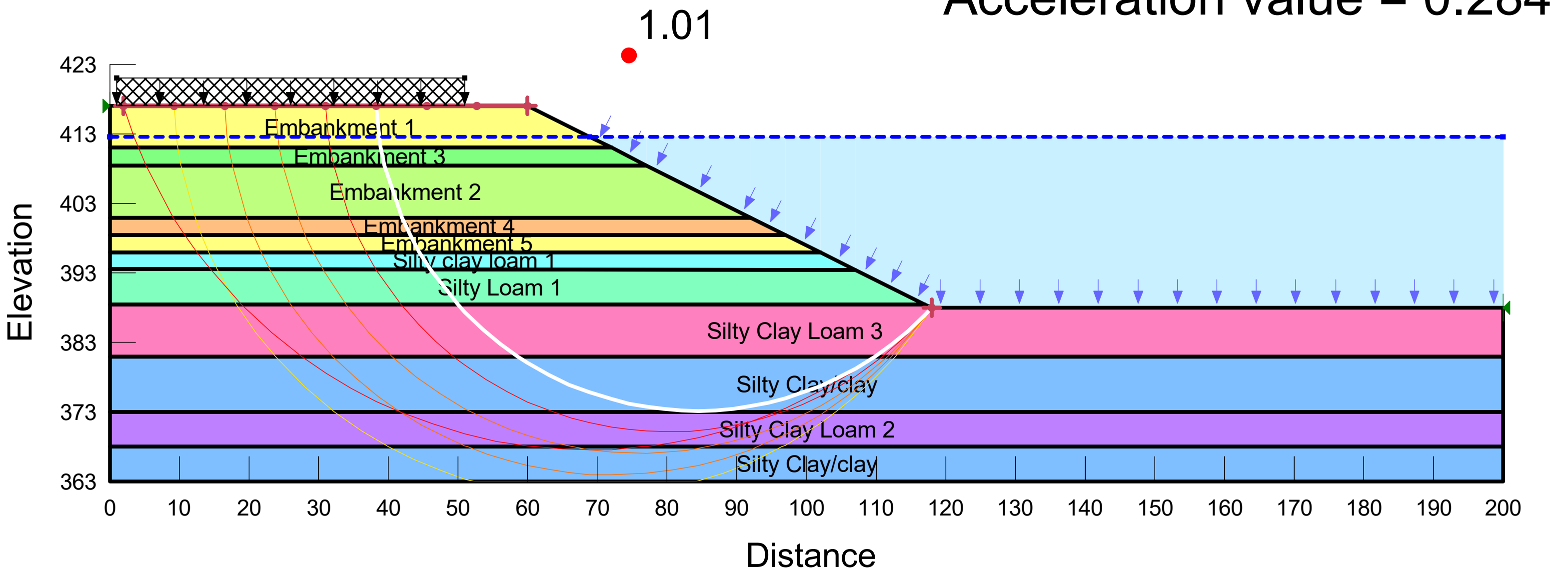
Color	Name	Material Model	Unit Weight (pcf)	Effective Cohesion (psf)	Effective Friction Angle (°)	Phi-B (°)
🟨	Embankment 1	Mohr-Coulomb	120	50	28	0
🟩	Embankment 2	Mohr-Coulomb	120	100	26	0
🟩	Embankment 3	Mohr-Coulomb	120	25	28	0
🟧	Embankment 4	Mohr-Coulomb	120	50	28	0
🟨	Embankment 5	Mohr-Coulomb	120	100	26	0
🟦	Silty clay loam 1	Mohr-Coulomb	120	50	28	0
🟪	Silty Clay Loam 2	Mohr-Coulomb	120	50	27	0
🟥	Silty Clay Loam 3	Mohr-Coulomb	120	100	27	0
🟦	Silty Clay/clay	Mohr-Coulomb	120	100	26	0
🟩	Silty Loam 1	Mohr-Coulomb	120	50	28	0

2-S Drained



Color	Name	Material Model	Unit Weight (pcf)	Effective Cohesion (psf)	Effective Friction Angle (°)	Phi-B (°)
🟨	Embankment 1	Mohr-Coulomb	120	50	28	0
🟩	Embankment 2	Mohr-Coulomb	120	100	26	0
🟩	Embankment 3	Mohr-Coulomb	120	25	28	0
🟧	Embankment 4	Mohr-Coulomb	120	50	28	0
🟨	Embankment 5	Mohr-Coulomb	120	100	26	0
🟦	Silty clay loam 1	Mohr-Coulomb	120	50	28	0
🟪	Silty Clay Loam 2	Mohr-Coulomb	120	50	27	0
🟥	Silty Clay Loam 3	Mohr-Coulomb	120	100	27	0
🟦	Silty Clay/clay	Mohr-Coulomb	120	100	26	0
🟩	Silty Loam 1	Mohr-Coulomb	120	50	28	0

2-S Seismic
Acceleration value = 0.284g



Appendix D:

Seismic Site Class and Liquefaction Spreadsheets

SEISMIC SITE CLASS DETERMINATION

I.D.O.T. BBS FOUNDATIONS AND GEOTECHNICAL UNIT

Modified on 12/10/10

PROJECT TITLE=====I-57 over Gun Creek

Substructure 1

Base of Substruct. Elev. (or ground surf for bents) 410.4 ft.
Pile or Shaft Dia. 12 inches
Boring Number 1-S
Top of Boring Elev. 417.7 ft.

Approximate Fixity Elev. 404.4 ft.

Individual Site Class Definition:

N (bar): 6 (Blows/ft.) Soil Site Class E
N_{ch} (bar): 17 (Blows/ft.) Soil Site Class D <----Controls
s_u (bar): 1.53 (ksf) Soil Site Class D

Seismic Soil Column Depth (ft)	Bot. Of Sample Elevation	Sample Thick. (ft.)	N	Qu (tsf)	Layer Description Boundary
	415.7	2.00	6	3.10	
	413.7	2.00	6	3.10	B
	411.7	2.00	9	0.30	
	409.2	2.50	6	0.20	
	406.7	2.50	11	0.20	
1.2	403.2	3.50	7	0.30	B
3.2	401.2	2.00	9	1.50	B
5.7	398.7	2.50	10	2.10	B
8.2	396.2	2.50	7	0.60	B
10.2	394.2	2.00	4	1.00	
12.7	391.7	2.50	2	0.90	
15.2	389.2	2.50	1	0.70	
17.7	386.7	2.50	2	0.70	
20.2	384.2	2.50	0	0.50	
22.7	381.7	2.50	2	0.90	
25.7	378.7	3.00	6	0.90	B
28.2	376.2	2.50	6	1.60	
31.2	373.2	3.00	6	1.60	B
33.7	370.7	2.50	4	0.60	
36.2	368.2	2.50	4	0.60	B
38.7	365.7	2.50	4		
41.2	363.2	2.50	4		
43.7	360.7	2.50	4		
46.2	358.2	2.50	4		
47.7	356.7	1.50	4		B
48.7	355.7	1.00	91		B
94.0	310.4	45.30	100	5.00	R

Substructure 2

Base of Substruct. Elev. (or ground surf for bents) 410.4 ft.
Pile or Shaft Dia. 12 inches
Boring Number 2-S
Top of Boring Elev. 417 ft.

Approximate Fixity Elev. 404.4 ft.

Individual Site Class Definition:

N (bar): 13 (Blows/ft.) Soil Site Class E
N_{ch} (bar): NA (Blows/ft.) NA
s_u (bar): 1.56 (ksf) Soil Site Class D <----Controls

Seismic Soil Column Depth (ft)	Bot. Of Sample Elevation	Sample Thick. (ft.)	N	Qu (tsf)	Layer Description Boundary
	415.0	2.00	18	0.50	
	413.0	2.00	5	0.50	
	411.0	2.00	5	0.50	B
	408.5	2.50	12	0.10	B
	406.0	2.50	9	1.80	
0.9	403.5	2.50	7	1.60	B
3.4	401.0	2.50	8	1.80	B
5.9	398.5	2.50	13	0.50	B
8.4	396.0	2.50	7	1.80	B
10.9	393.5	2.50	10	0.80	
13.4	391.0	2.50	0	0.30	
15.9	388.5	2.50	0	0.10	B
18.4	386.0	2.50	5	1.40	B
20.9	383.5	2.50	6	0.80	
23.4	381.0	2.50	6	1.00	B
25.9	378.5	2.50	6	1.90	B
28.4	376.0	2.50	6	1.80	
30.4	374.0	2.00	6	1.80	
31.4	373.0	1.00	6	1.80	B
33.9	370.5	2.50	0	0.60	
36.4	368.0	2.50	0	0.60	B
38.9	365.5	2.50	12	1.90	
41.4	363.0	2.50	12	1.90	B
94.0	310.4	52.60	100	5.00	R

Substructure 3

Base of Substruct. Elev. (or ground surf for bents) ft.
Pile or Shaft Dia. inches
Boring Number
Top of Boring Elev. ft.

Approximate Fixity Elev. ft.

Individual Site Class Definition:

N (bar): (Blows/ft.) NA
N_{ch} (bar): (Blows/ft.) NA
s_u (bar): (ksf) NA

Seismic Soil Column Depth (ft)	Bot. Of Sample Elevation	Sample Thick. (ft.)	N	Qu (tsf)	Layer Description Boundary

Substructure 4

Base of Substruct. Elev. (or ground surf for bents) ft.
Pile or Shaft Dia. inches
Boring Number
Top of Boring Elev. ft.

Approximate Fixity Elev. ft.

Individual Site Class Definition:

N (bar): (Blows/ft.) NA
N_{ch} (bar): (Blows/ft.) NA
s_u (bar): (ksf) NA

Seismic Soil Column Depth (ft)	Bot. Of Sample Elevation	Sample Thick. (ft.)	N	Qu (tsf)	Layer Description Boundary

Global Site Class Definition: Substructures 1 through 2

N (bar): 10 (Blows/ft.) Soil Site Class E
N_{ch} (bar): 57 (Blows/ft.) Soil Site Class C
s_u (bar): 1.55 (ksf) Soil Site Class D <----Controls

Illinois Department of Transportation

LIQUEFACTION ANALYSIS

REFERENCE BORING NUMBER ===================================== 1-S
ELEVATION OF BORING GROUND SURFACE ========================= 417.70 FT.
DEPTH TO GROUNDWATER - DURING DRILLING ====================== 21.50 FT. (Below Boring Ground Surface)
DEPTH TO GROUNDWATER - DURING EARTHQUAKE ================== 18.00 FT. (Below Finished Grade Cut or Fill Surface)
PEAK HORIZ. GROUND SURFACE ACCELERATION COEFFICIENT (As) ===== 0.148
EARTHQUAKE MOMENT MAGNITUDE ================================ 7.5
FINISHED GRADE FILL OR CUT FROM BORING SURFACE =============== 0.00 FT.
HAMMER EFFICIENCY== 88 %
BOREHOLE DIAMETER== 6 IN.
SAMPLING METHOD== Sampler w/out Liners

EQ MAGNITUDE SCALING FACTOR
(MSF) = **1.000**

AVG. SHEAR WAVE VELOCITY (top 40')
$V^*_{s,40'}$ = **332** FT./SEC.

PGA CALCULATOR
Earthquake Moment Magnitude = 7.5
Source-To-Site Distance, R (km) = 130
Ground Motion Prediction Equations = NMSZ
PGA = **0.116**

	BORING DATA							CONDITIONS DURING DRILLING					CONDITIONS DURING EARTHQUAKE							
ELEV. OF SAMPLE (FT.)	BORING SAMPLE DEPTH (FT.)	SPT N VALUE (BLOWS)	UNCONF. COMPR. STR., Q_u (TSF.)	% FINES < #200 (%)	PLAST. INDEX PI	LIQUID LIMIT LL	MOIST. CONTENT w_c (%)	EFFECTIVE UNIT WT. (KCF.)	VERT. STRESS (KSF.)	CORR. SPT N VALUE $(N_1)_{60}$	EQUIV. CLN. SAND SPT N VALUE $(N_1)_{60cs}$	CRR RESIST. MAG 7.5 $CRR_{7.5}$	EFFECTIVE UNIT WT. (KCF.)	VERT. STRESS (KSF.)	TOTAL VERT. STRESS (KSF.)	OVER-BURDEN CORR. FACT. (Ks)	CORR. RESIST. $CRR_{7.5}$ CRR	SOIL MASS PART. FACTOR (r_d)	EQ INDUCED CSR	FACTOR OF SAFETY * CRR/CSR
413.7	4	6	3.10				17	0.135	0.540	11.528	11.528	0.127	0.135	0.540	0.540	1.391	**0.176**	0.926	**0.089**	**N.L. (1)**
411.7	6	9	0.30				14	0.108	0.756	16.560	16.560	0.176	0.108	0.756	0.756	1.324	**0.233**	0.885	**0.085**	**N.L. (1)**
409.2	8.5	6	0.20				16	0.104	1.016	10.399	10.399	0.117	0.104	1.016	1.016	1.188	**0.139**	0.833	**0.080**	**N.L. (1)**
406.7	11	11	0.20				15	0.104	1.276	19.580	19.580	0.210	0.104	1.276	1.276	1.159	**0.244**	0.781	**0.075**	**N.L. (1)**
403.2	14.5	7	0.30				16	0.108	1.654	11.689	11.689	0.128	0.108	1.654	1.654	1.062	**0.136**	0.711	**0.068**	**N.L. (1)**
401.2	16.5	9	1.50				17	0.126	1.906	14.517	14.517	0.155	0.126	1.906	1.906	1.028	**0.160**	0.674	**0.065**	**N.L. (1)**
398.7	19	10	2.10		12	30	17	0.130	2.231	15.360	15.360	0.164	0.068	2.076	2.138	1.006	**0.165**	0.631	**0.063**	**N.L. (2)**
396.2	21.5	7	0.60		12	30	28	0.116	2.521	10.292	10.292	0.116	0.178	2.521	2.739	0.960	**0.111**	0.594	**0.062**	**N.L. (2)**
394.2	23.5	4	1.00		12	30	26	0.059	2.639	5.798	5.798	0.078	0.059	2.639	2.982	0.956	**0.075**	0.568	**0.062**	**N.L. (2)**
391.7	26	2	0.90		12	30	28	0.058	2.784	2.844	2.844	0.057	0.058	2.784	3.283	0.947	**0.054**	0.540	**0.061**	**N.L. (2)**
389.2	28.5	1	0.70		12	30	27	0.055	2.922	1.395	1.395	0.050	0.055	2.922	3.577	0.938	**0.047**	0.517	**0.061**	**N.L. (2)**
386.7	31	2	0.70		12	30	29	0.055	3.059	2.733	2.733	0.057	0.055	3.059	3.870	0.929	**0.053**	0.498	**0.061**	**N.L. (2)**
384.2	33.5	1	0.50		12	30	26	0.051	3.187	1.341	1.341	0.050	0.051	3.187	4.154	0.922	**0.046**	0.482	**0.060**	**N.L. (2)**
381.7	36	2	0.90		12	30	27	0.058	3.332	2.626	2.626	0.056	0.058	3.332	4.455	0.914	**0.051**	0.470	**0.060**	**N.L. (2)**
378.7	39	6	0.90		12	30	31	0.058	3.506	7.679	7.679	0.093	0.058	3.506	4.816	0.897	**0.084**	0.459	**0.061**	**N.L. (2)**
373.2	44.5	6	1.60		12	30	32	0.065	3.863	7.297	7.297	0.090	0.065	3.863	5.517	0.879	**0.079**	0.444	**0.061**	**N.L. (2)**
368.2	49.5	4	0.60		12	30	28	0.053	4.128	4.694	4.694	0.070	0.053	4.128	6.094	0.875	**0.061**	0.437	**0.062**	**N.L. (2)**
363.2	54.5	11	0.4		10	27	19	0.049	4.373	12.496	12.496	0.136	0.049	4.373	6.651	0.836	**0.114**	0.432	**0.063**	**N.L. (2)**
356.7	61	4		20			22	0.053	4.718	4.339	8.298	0.098	0.053	4.718	7.401	0.838	**0.082**	0.429	**0.065**	**1.262** (C)
355.7	62	91					15	0.082	4.800	115.372	115.372	0.837	0.082	4.800	7.545	0.721	**0.604**	0.429	**0.065**	**N.L. (3)**
345.7	72	100	5					0.079	5.590	114.528	114.528	0.831	0.079	5.590	8.959	0.679	**0.564**	0.416	**0.064**	**N.L. (3)**

* FACTOR OF SAFETY DESCRIPTIONS

N.L. (1) = NOT LIQUEFIABLE, ABOVE EQ GROUND WATER ELEVATION
N.L. (2) = NOT LIQUEFIABLE, PI $\geq$ 12 OR w_c/LL $\leq$ 0.85
N.L. (3) = NOT LIQUEFIABLE, $(N_1)_{60}$ > 25
(C) = CONTRACTIVE SOIL TYPES
(D) = DILATIVE SOIL TYPES

Illinois Department of Transportation

LIQUEFACTION ANALYSIS

REFERENCE BORING NUMBER ====================================2-S
ELEVATION OF BORING GROUND SURFACE ========================= 417.00 FT.
DEPTH TO GROUNDWATER - DURING DRILLING ====================== 18.00 FT. (Below Boring Ground Surface)
DEPTH TO GROUNDWATER - DURING EARTHQUAKE ================== 18.00 FT. (Below Finished Grade Cut or Fill Surface)
PEAK HORIZ. GROUND SURFACE ACCELERATION COEFFICIENT (As) ===== 0.148
EARTHQUAKE MOMENT MAGNITUDE =============================== 7.5
FINISHED GRADE FILL OR CUT FROM BORING SURFACE =============== 0.00 FT.
HAMMER EFFICIENCY== 88 %
BOREHOLE DIAMETER== 6 IN.
SAMPLING METHOD==Sampler w/out Liners

EQ MAGNITUDE SCALING FACTOR
(MSF) = **1.000**

AVG. SHEAR WAVE VELOCITY (top 40')
$\bar{V}_{s,40'}$ = **390** FT./SEC.

PGA CALCULATOR
Earthquake Moment Magnitude = 7.5
Source-To-Site Distance, R (km) = 130
Ground Motion Prediction Equations = NMSZ
PGA = **0.116**

	BORING DATA								CONDITIONS DURING DRILLING					CONDITIONS DURING EARTHQUAKE							
ELEV. OF SAMPLE (FT.)	BORING SAMPLE DEPTH (FT.)	SPT N VALUE (BLOWS)	UNCONF. COMPR. STR., Q_u (TSF.)	% FINES < #200 (%)	PLAST. INDEX PI	LIQUID LIMIT LL	MOIST. CONTENT w_c (%)	EFFECTIVE UNIT WT. (KCF.)	EFFECTIVE VERT. STRESS (KSF.)	CORR. SPT N VALUE $(N_1)_{60}$	EQUIV. CLN. SAND SPT N VALUE $(N_1)_{60cs}$	CRR RESIST. MAG 7.5 $CRR_{7.5}$	EFFECTIVE UNIT WT. (KCF.)	EFFECTIVE VERT. STRESS (KSF.)	TOTAL VERT. STRESS (KSF.)	OVER-BURDEN CORR. FACT. (Ks)	CORR. RESIST. $CRR_{7.5}$ CRR	SOIL MASS PART. FACTOR (r_d)	EQ INDUCED CSR	FACTOR OF SAFETY * CRR/CSR	
414.5	2.5	18	0.50				6	0.114	0.285	44.447	44.447	0.229	0.114	0.285	0.285	1.500	**0.343**	0.969	**0.093**	**N.L. (1)**	
412	5	5	0.50				10	0.114	0.570	9.514	9.514	0.109	0.114	0.570	0.570	1.350	**0.147**	0.935	**0.090**	**N.L. (1)**	
409.5	7.5	12	0.10				16	0.098	0.815	22.597	22.597	0.251	0.098	0.815	0.815	1.345	**0.337**	0.896	**0.086**	**N.L. (1)**	
407	10	9	1.80				19	0.128	1.135	15.954	15.954	0.170	0.128	1.135	1.135	1.183	**0.201**	0.854	**0.082**	**N.L. (1)**	
404.5	12.5	7	1.60				22	0.127	1.453	11.900	11.900	0.130	0.127	1.453	1.453	1.096	**0.143**	0.811	**0.078**	**N.L. (1)**	
402	15	8	1.80				24	0.128	1.773	13.078	13.078	0.141	0.128	1.773	1.773	1.046	**0.148**	0.767	**0.074**	**N.L. (1)**	
399.5	17.5	13	0.50		8	29	15	0.114	2.058	21.065	21.065	0.229	0.114	2.058	2.058	1.009	**0.231**	0.724	**0.070**	**N.L. (1)**	
397	20	7	1.80		12	30	20	0.066	2.223	10.844	10.844	0.121	0.066	2.223	2.347	0.989	**0.119**	0.683	**0.069**	**N.L. (2)**	
394.5	22.5	10	0.80		12	30	25	0.057	2.365	15.242	15.242	0.162	0.057	2.365	2.646	0.972	**0.158**	0.646	**0.069**	**N.L. (2)**	
392	25	1	0.30		8	29	27	0.046	2.480	1.503	1.503	0.051	0.046	2.480	2.917	0.969	**0.049**	0.612	**0.069**	0.710	**(C)**
389.5	27.5	1	0.10		8	29	29	0.035	2.568	1.488	1.488	0.051	0.035	2.568	3.160	0.962	**0.049**	0.583	**0.069**	0.710	**(C)**
387	30	5	1.40		12	30	25	0.063	2.725	7.254	7.254	0.090	0.063	2.725	3.474	0.948	**0.085**	0.559	**0.069**	**N.L. (2)**	
384.5	32.5	6	0.80		12	30	25	0.057	2.868	8.511	8.511	0.100	0.057	2.868	3.772	0.935	**0.094**	0.538	**0.068**	**N.L. (2)**	
382	35	6	1.00		12	30	26	0.059	3.015	8.315	8.315	0.099	0.059	3.015	4.076	0.925	**0.091**	0.522	**0.068**	**N.L. (2)**	
379.5	37.5	6	1.90		12	30	25	0.067	3.183	8.098	8.098	0.097	0.067	3.183	4.399	0.915	**0.088**	0.508	**0.068**	**N.L. (2)**	
377	40	6	1.80		12	30	27	0.066	3.348	7.895	7.895	0.095	0.066	3.348	4.720	0.905	**0.086**	0.497	**0.067**	**N.L. (2)**	
371.5	45.5	1	0.60		12	30	28	0.053	3.639	1.261	1.261	0.050	0.053	3.639	5.355	0.898	**0.045**	0.480	**0.068**	**N.L. (2)**	
366.5	50.5	12	1.90		12	30	20	0.067	3.974	14.427	14.427	0.154	0.067	3.974	6.002	0.850	**0.131**	0.471	**0.068**	**N.L. (2)**	
362.7	54.3	100						0.083	4.289	######	135.880	0.992	0.083	4.289	6.555	0.754	**0.748**	0.467	**0.069**	**N.L. (3)**	

* FACTOR OF SAFETY DESCRIPTIONS

N.L. (1) = NOT LIQUEFIABLE, ABOVE EQ GROUND WATER ELEVATION
N.L. (2) = NOT LIQUEFIABLE, PI ≥ 12 OR w_c/LL ≤ 0.85
N.L. (3) = NOT LIQUEFIABLE, $(N_1)_{60}$ > 25
(C) = CONTRACTIVE SOIL TYPES
(D) = DILATIVE SOIL TYPES

Illinois Department of Transportation

LIQUEFACTION ANALYSIS

REFERENCE BORING NUMBER ===================================== Boring No.3
ELEVATION OF BORING GROUND SURFACE ========================= 398.70 FT.
DEPTH TO GROUNDWATER - DURING DRILLING ====================== 12.00 FT. (Below Boring Ground Surface)
DEPTH TO GROUNDWATER - DURING EARTHQUAKE ================== 12.00 FT. (Below Finished Grade Cut or Fill Surface)
PEAK HORIZ. GROUND SURFACE ACCELERATION COEFFICIENT (As) ===== 0.148
EARTHQUAKE MOMENT MAGNITUDE =============================== 7.5
FINISHED GRADE FILL OR CUT FROM BORING SURFACE =============== 0.00 FT.
HAMMER EFFICIENCY== 88 %
BOREHOLE DIAMETER== 6 IN.
SAMPLING METHOD== Sampler w/out Liners

EQ MAGNITUDE SCALING FACTOR
(MSF) = **1.000**

AVG. SHEAR WAVE VELOCITY (top 40')
$V_{s,40'}$ = **496** FT./SEC.

PGA CALCULATOR
Earthquake Moment Magnitude = 7.5
Source-To-Site Distance, R (km) = 130
Ground Motion Prediction Equations = NMSZ
PGA = **0.116**

	BORING DATA							CONDITIONS DURING DRILLING					CONDITIONS DURING EARTHQUAKE							
ELEV. OF SAMPLE (FT.)	BORING SAMPLE DEPTH (FT.)	SPT N VALUE (BLOWS)	UNCONF. COMPR. STR., Q_u (TSF.)	% FINES < #200 (%)	PLAST. INDEX PI	LIQUID LIMIT LL	MOIST. CONTENT w_c (%)	EFFECTIVE UNIT WT. (KCF.)	EFFECTIVE VERT. STRESS (KSF.)	CORR. SPT N VALUE $(N_1)_{60}$	EQUIV. CLN. SAND SPT N VALUE $(N_1)_{60cs}$	CRR RESIST. MAG 7.5 $CRR_{7.5}$	EFFECTIVE UNIT WT. (KCF.)	EFFECTIVE VERT. STRESS (KSF.)	TOTAL VERT. STRESS (KSF.)	OVER-BURDEN CORR. FACT. (Ks)	CORR. RESIST. $CRR_{7.5}$ CRR	SOIL MASS PART. FACTOR (r_d)	EQ INDUCED CSR	FACTOR OF SAFETY * CRR/CSR
395.7	3	4			8	30	13	0.108	0.324	8.264	8.264	0.098	0.108	0.324	0.324	1.500	**0.147**	0.984	**0.095**	**N.L. (1)**
392.2	6.5	19	1.20		8	30	15	0.124	0.758	39.315	39.315	0.098	0.124	0.758	0.758	1.500	**0.148**	0.960	**0.092**	**N.L. (1)**
389.7	9	10	1.00		8	30	21	0.122	1.063	17.832	17.832	0.190	0.122	1.063	1.063	1.214	**0.231**	0.939	**0.090**	**N.L. (1)**
387.2	11.5	8	1.00		12	30	23	0.122	1.368	13.629	13.629	0.147	0.122	1.368	1.368	1.118	**0.164**	0.915	**0.088**	**N.L. (1)**
384.7	14	4	0.50		12	30	28	0.051	1.496	6.893	6.893	0.087	0.051	1.496	1.620	1.077	**0.093**	0.888	**0.093**	**N.L. (2)**
382.2	16.5	6	1.10		12	30	26	0.060	1.646	10.280	10.280	0.116	0.060	1.646	1.926	1.061	**0.123**	0.857	**0.097**	**N.L. (2)**
379.7	19	8	1.70		12	41	28	0.065	1.808	13.483	13.483	0.145	0.065	1.808	2.245	1.041	**0.151**	0.825	**0.099**	**N.L. (2)**
377.2	21.5	7	1.60		12	41	26	0.065	1.971	11.547	11.547	0.127	0.065	1.971	2.563	1.018	**0.129**	0.791	**0.099**	**N.L. (2)**
374.7	24	7	1.70		12	41	27	0.065	2.133	11.266	11.266	0.124	0.065	2.133	2.882	0.999	**0.124**	0.758	**0.099**	**N.L. (2)**
372.2	26.5	6	1.50		12	30	30	0.064	2.293	9.410	9.410	0.108	0.064	2.293	3.198	0.982	**0.106**	0.725	**0.097**	**N.L. (2)**
369.7	29	8	1.20		12	30	27	0.061	2.446	12.233	12.233	0.133	0.061	2.446	3.506	0.966	**0.129**	0.695	**0.096**	**N.L. (2)**
367.2	31.5	15	2.00		8	27	15	0.067	2.613	23.015	23.015	0.257	0.067	2.613	3.830	0.937	**0.241**	0.667	**0.094**	**N.L. (2)**
364.7	34	12	1.50		8	27	21	0.064	2.773	17.445	17.445	0.186	0.064	2.773	4.146	0.928	**0.172**	0.643	**0.092**	**N.L. (2)**
362.2	36.5	5					18	0.055	2.911	7.076	7.076	0.088	0.055	2.911	4.439	0.935	**0.083**	0.622	**0.091**	**0.912** **(C)**
359.7	39	21	1.50		12	30	17	0.064	3.071	30.920	30.920	0.549	0.064	3.071	4.755	0.874	**0.480**	0.604	**0.090**	**N.L. (2)**
357.2	41.5	62					14	0.078	3.266	97.944	97.944	0.705	0.078	3.266	5.106	0.841	**0.593**	0.589	**0.089**	**N.L. (3)**
355.2	43.5	100						0.083	3.432	######	153.932	1.127	0.083	3.432	5.397	0.825	**0.929**	0.580	**0.088**	**N.L. (3)**

* FACTOR OF SAFETY DESCRIPTIONS
N.L. (1) = NOT LIQUEFIABLE, ABOVE EQ GROUND WATER ELEVATION
N.L. (2) = NOT LIQUEFIABLE, PI ≥ 12 OR w_c/LL ≤ 0.85
N.L. (3) = NOT LIQUEFIABLE, $(N_1)_{60}$ > 25
(C) = CONTRACTIVE SOIL TYPES
(D) = DILATIVE SOIL TYPES

Illinois Department of Transportation

LIQUEFACTION ANALYSIS

REFERENCE BORING NUMBER ====================================Boring No.4
ELEVATION OF BORING GROUND SURFACE ========================= 398.40 FT.
DEPTH TO GROUNDWATER - DURING DRILLING ====================== 12.00 FT. (Below Boring Ground Surface)
DEPTH TO GROUNDWATER - DURING EARTHQUAKE ================== 12.00 FT. (Below Finished Grade Cut or Fill Surface)
PEAK HORIZ. GROUND SURFACE ACCELERATION COEFFICIENT (As) ===== 0.148
EARTHQUAKE MOMENT MAGNITUDE =============================== 7.5
FINISHED GRADE FILL OR CUT FROM BORING SURFACE =============== 0.00 FT.
HAMMER EFFICIENCY== 88 %
BOREHOLE DIAMETER== 6 IN.
SAMPLING METHOD==Sampler w/out Liners

EQ MAGNITUDE SCALING FACTOR
(MSF) = **1.000**

AVG. SHEAR WAVE VELOCITY (top 40')
$\bar{V}_{s,40'}$ = **440** FT./SEC.

PGA CALCULATOR
Earthquake Moment Magnitude = 7.5
Source-To-Site Distance, R (km) = 130
Ground Motion Prediction Equations = NMSZ
PGA = **0.116**

	BORING DATA							*CONDITIONS DURING DRILLING*					*CONDITIONS DURING EARTHQUAKE*							
ELEV. OF SAMPLE (FT.)	*BORING SAMPLE DEPTH (FT.)*	*SPT N VALUE (BLOWS)*	*UNCONF. COMPR. STR., Q_u (TSF.)*	*% FINES < #200 (%)*	*PLAST. INDEX PI*	*LIQUID LIMIT LL*	*MOIST. CONTENT w_c (%)*	*EFFECTIVE UNIT WT. (KCF.)*	*EFFECTIVE VERT. STRESS (KSF.)*	*CORR. SPT N VALUE $(N_1)_{60}$*	*EQUIV. CLN. SAND SPT N VALUE $(N_1)_{60cs}$*	*CRR RESIST. MAG 7.5 $CRR_{7.5}$*	*EFFECTIVE UNIT WT. (KCF.)*	*EFFECTIVE VERT. STRESS (KSF.)*	*TOTAL VERT. STRESS (KSF.)*	*OVER-BURDEN CORR. FACT. (Ks)*	*CORR. RESIST. $CRR_{7.5}$ CRR*	*SOIL MASS PART. FACTOR (r_d)*	*EQ INDUCED CSR*	*FACTOR OF SAFETY * CRR/CSR*
395.4	3	4			8	30	23	0.108	0.324	8.264	8.264	0.098	0.108	0.324	0.324	1.500	**0.147**	0.975	**0.094**	**N.L. (1)**
392.4	6	7	1.40		12	30	27	0.125	0.699	12.798	12.798	0.139	0.125	0.699	0.699	1.318	**0.183**	0.944	**0.091**	**N.L. (1)**
389.9	8.5	6	1.10		12	30	26	0.123	1.007	10.427	10.427	0.117	0.123	1.007	1.007	1.191	**0.139**	0.914	**0.088**	**N.L. (1)**
387.4	11	4	0.50		12	30	26	0.114	1.292	6.877	6.877	0.087	0.114	1.292	1.292	1.111	**0.096**	0.880	**0.085**	**N.L. (1)**
384.9	13.5	4	0.80		12	30	22	0.057	1.434	6.947	6.947	0.087	0.057	1.434	1.528	1.087	**0.095**	0.844	**0.086**	**N.L. (2)**
382.4	16	5	0.90		12	30	25	0.058	1.579	8.659	8.659	0.101	0.058	1.579	1.829	1.068	**0.108**	0.806	**0.090**	**N.L. (2)**
379.9	18.5	7	1.20		12	41	28	0.061	1.732	11.964	11.964	0.131	0.061	1.732	2.137	1.051	**0.137**	0.767	**0.091**	**N.L. (2)**
377.4	21	7	2.20		12	41	44	0.069	1.904	11.689	11.689	0.128	0.069	1.904	2.466	1.026	**0.132**	0.729	**0.091**	**N.L. (2)**
374.9	23.5	10	2.00		12	41	24	0.067	2.072	16.294	16.294	0.173	0.067	2.072	2.789	1.006	**0.174**	0.693	**0.090**	**N.L. (2)**
372.4	26	4	0.70		12	30	24	0.055	2.209	6.375	6.375	0.083	0.055	2.209	3.083	0.991	**0.082**	0.660	**0.089**	**N.L. (2)**
369.9	28.5	8	1.20		12	30	27	0.061	2.362	12.430	12.430	0.135	0.061	2.362	3.391	0.974	**0.132**	0.630	**0.087**	**N.L. (2)**
367.4	31	16					8	0.065	2.524	25.214	25.214	0.296	0.065	2.524	3.710	0.945	**0.280**	0.604	**0.085**	**N.L. (3)**
364.9	33.5	2					19	0.048	2.644	2.964	2.964	0.058	0.048	2.644	3.986	0.957	**0.056**	0.582	**0.084**	**0.667** **(C)**
362.4	36	28					18	0.070	2.819	45.527	45.527	0.246	0.070	2.819	4.317	0.892	**0.219**	0.564	**0.083**	**N.L. (3)**
359.9	38.5	14	2.70		8	27	17	0.071	2.997	19.870	19.870	0.214	0.071	2.997	4.650	0.904	**0.193**	0.548	**0.082**	**N.L. (2)**
357.4	41	65					20	0.078	3.192	######	103.948	0.751	0.078	3.192	5.001	0.849	**0.637**	0.536	**0.081**	**N.L. (3)**
355.4	43	100						0.083	3.358	######	155.776	1.141	0.083	3.358	5.292	0.832	**0.949**	0.528	**0.080**	**N.L. (3)**
352.9	45.5	100						0.083	3.565	######	150.890	1.104	0.083	3.565	5.655	0.812	**0.897**	0.520	**0.079**	**N.L. (3)**
350.4	48	100						0.083	3.773	######	146.293	1.070	0.083	3.773	6.019	0.794	**0.850**	0.513	**0.079**	**N.L. (3)**
348.4	50	100						0.083	3.939	######	142.799	1.044	0.083	3.939	6.310	0.781	**0.815**	0.509	**0.078**	**N.L. (3)**

* FACTOR OF SAFETY DESCRIPTIONS

N.L. (1) = NOT LIQUEFIABLE, ABOVE EQ GROUND WATER ELEVATION
N.L. (2) = NOT LIQUEFIABLE, PI $\geq$ 12 OR w_c/LL $\leq$ 0.85
N.L. (3) = NOT LIQUEFIABLE, $(N_1)_{60}$ > 25
(C) = CONTRACTIVE SOIL TYPES
(D) = DILATIVE SOIL TYPES

Appendix E:

Estimated Pile Length Spreadsheets

Illinois Department of Transportation

IDOT STATIC METHOD OF ESTIMATING PILE LENGTH

SUBSTRUCTURE=================================== North Abutments
REFERENCE BORING ================================ 1-S
LRFD or ASD or SEISMIC ============================= LRFD
PILE CUTOFF ELEV. ================================= 412.40 ft
GROUND SURFACE ELEV. AGAINST PILE DURING DRIVING = 410.40 ft
GEOTECHNICAL LOSS TYPE (None, Scour, Liquef., DD) ====== None
BOTTOM ELEV. OF SCOUR, LIQUEF., or DD ================= ft
TOP ELEV. OF LIQUEF. (so layers above apply DD) =============== ft

TOTAL FACTORED SUBSTRUCTURE LOAD =============== 1800 kips
TOTAL LENGTH OF SUBSTRUCTURE (along skew)========== 153.50 ft
NUMBER OF ROWS OF PILES PER SUBSTRUCTURE ======= 1
Approx. Factored Loading Applied per pile at 8 ft. Cts ============ 93.81 KIPS
Approx. Factored Loading Applied per pile at 3 ft. Cts ============ 35.18 KIPS

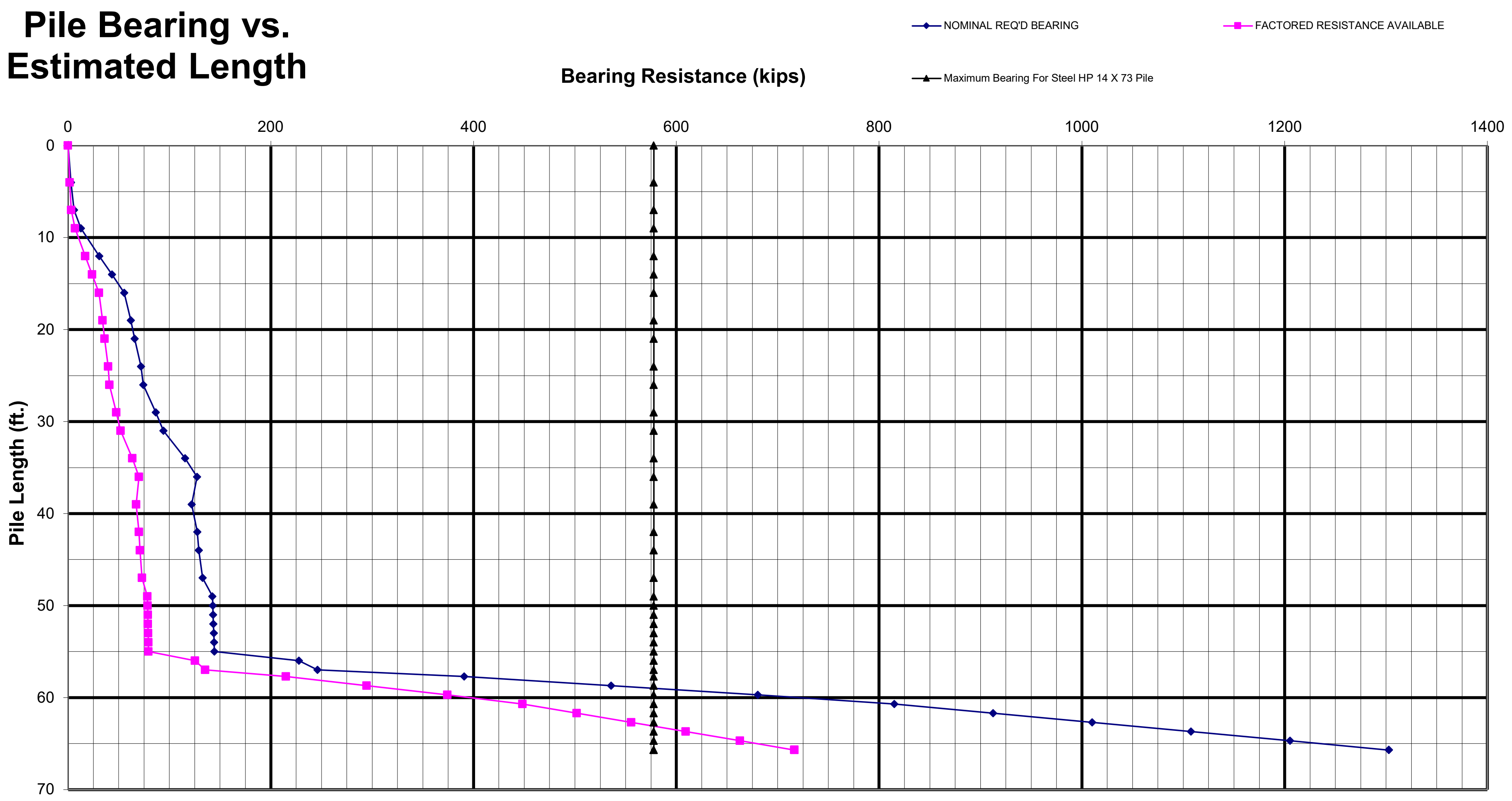
PILE TYPE AND SIZE ============= Steel HP 14 X 73
Plugged Pile Perimeter========================== 4.700 FT. Unplugged Pile Perimeter=============== 6.975 FT.
Plugged Pile End Bearing Area==================== 1.379 SQFT. Unplugged Pile End Bearing Area======== 0.149 SQFT.

MAX. REQUIRED BEARING & RESISTANCE for Selected Pile, Soil Profile, & Losses

Maximum Nominal Req'd Bearing of Pile	Maximum Nominal Req.d Bearing of Boring	Maximum Factored Resistance Available in Boring	Maximum Pile Driveable Length in Boring
578 KIPS	**578** KIPS	**318** KIPS	**60** FT.

BOT. OF LAYER ELEV. (FT.)	LAYER THICK. (FT.)	UNCONF. COMPR. STRENGTH (TSF.)	S.P.T. N VALUE (BLOWS)	GRANULAR OR ROCK LAYER DESCRIPTION	NOMINAL PLUGGED			NOMINAL UNPLUG'D			NOMINAL REQ'D BEARING (KIPS)	FACTORED GEOTECH. LOSS FROM SCOUR or DD (KIPS)	FACTORED GEOTECH. LOSS LOAD FROM DD (KIPS)	FACTORED RESISTANCE AVAILABLE (KIPS)	ESTIMATED PILE LENGTH (FT.)
					SIDE RESIST. (KIPS)	END BRG. RESIST. (KIPS)	TOTAL RESIST. (KIPS)	SIDE RESIST. (KIPS)	END BRG. RESIST. (KIPS)	TOTAL RESIST. (KIPS)					
408.20	2.20	0.20			1.7		5.6	2.5		***2.9***	3	0	0	2	4
405.70	2.50	0.20			1.9	3.9	9.4	2.9	0.4	***6.0***	6	0	0	3	7
403.20	2.50	0.30			2.8	5.8	35.5	4.2	0.6	***12.7***	13	0	0	7	9
400.70	2.50	1.50			11.3	29.0	58.4	16.8	3.1	***30.8***	31	0	0	17	12
398.20	2.50	2.10			14.1	40.6	***43.5***	20.9	4.4	48.6	43	0	0	24	14
396.20	2.00	0.60			4.3	11.6	***55.5***	6.4	1.2	55.8	56	0	0	31	16
393.70	2.50	1.00			8.3	19.3	***61.9***	12.4	2.1	68.0	62	0	0	34	19
391.20	2.50	0.90			7.7	17.4	***65.7***	11.4	1.9	78.9	66	0	0	36	21
388.70	2.50	0.70			6.2	13.5	***71.9***	9.2	1.5	88.1	72	0	0	40	24
386.20	2.50	0.70			6.2	13.5	***74.2***	9.2	1.5	96.9	74	0	0	41	26
383.70	2.50	0.50			4.6	9.7	***86.6***	6.8	1.0	104.5	87	0	0	48	29
381.20	2.50	0.90			7.7	17.4	***94.2***	11.4	1.9	115.9	94	0	0	52	31
378.70	2.50	0.90			7.7	17.4	***115.4***	11.4	1.9	128.7	115	0	0	63	34
376.20	2.50	1.60			11.8	30.9	***127.2***	17.5	3.3	146.2	127	0	0	70	36
373.20	3.00	1.60			14.2	30.9	***122.1***	21.0	3.3	165.2	122	0	0	67	39
370.70	2.50	0.60			5.4	11.6	***127.5***	8.0	1.2	173.2	127	0	0	70	42
368.20	2.50	0.60			5.4	11.6	***129.0***	8.0	1.2	180.8	129	0	0	71	44
365.70	2.50	0.40			3.7	7.7	***132.7***	5.5	0.8	186.3	133	0	0	73	47
363.20	2.50	0.40			3.7	7.7	***142.5***	5.5	0.8	192.5	142	0	0	78	49
362.20	1.00		4	Fine Sand	0.3	13.7	***142.8***	0.5	1.5	193.0	143	0	0	79	50
361.20	1.00		4	Fine Sand	0.3	13.7	***143.1***	0.5	1.5	193.5	143	0	0	79	51
360.20	1.00		4	Fine Sand	0.3	13.7	***143.4***	0.5	1.5	193.9	143	0	0	79	52
359.20	1.00		4	Fine Sand	0.3	13.7	***143.8***	0.5	1.5	194.4	144	0	0	79	53
358.20	1.00		4	Fine Sand	0.3	13.7	***144.1***	0.5	1.5	194.9	144	0	0	79	54
357.20	1.00		4	Fine Sand	0.3	13.7	***144.4***	0.5	1.5	195.4	144	0	0	79	55
356.70	0.50		4	Fine Sand	0.2	13.7	443.4	0.2	1.5	***227.8***	228	0	0	125	56
355.70	1.00		91	Fine Sand	14.7	312.6	424.6	21.8	33.7	***246.0***	246	0	0	135	57
354.70	1.00			Sandstone	97.6	279.1	522.2	144.8	30.1	***390.8***	391	0	0	215	57.7
353.70	1.00			Sandstone	97.6	279.1	619.8	144.8	30.1	***535.6***	536	0	0	295	58.7
352.70	1.00			Sandstone	97.6	279.1	717.3	144.8	30.1	***680.4***	~~680~~	~~0~~	~~0~~	~~374~~	~~59.7~~
351.70	1.00			Sandstone	97.6	279.1	***814.9***	144.8	30.1	825.2	~~815~~	~~0~~	~~0~~	~~448~~	~~60.7~~
350.70	1.00			Sandstone	97.6	279.1	***912.5***	144.8	30.1	970.1	~~913~~	~~0~~	~~0~~	~~502~~	~~61.7~~
349.70	1.00			Sandstone	97.6	279.1	***1010.1***	144.8	30.1	1114.9	~~1010~~	~~0~~	~~0~~	~~556~~	~~62.7~~
348.70	1.00			Sandstone	97.6	279.1	***1107.7***	144.8	30.1	1259.7	~~1108~~	~~0~~	~~0~~	~~609~~	~~63.7~~
347.70	1.00			Sandstone	97.6	279.1	***1205.3***	144.8	30.1	1404.5	~~1205~~	~~0~~	~~0~~	~~663~~	~~64.7~~
346.70	1.00			Sandstone	97.6	279.1	***1302.8***	144.8	30.1	1549.3	~~1303~~	~~0~~	~~0~~	~~717~~	~~65.7~~
345.70	1.00			Sandstone		279.1			30.1						

Pile Bearing vs. Estimated Length



Pile Design Table for North Abutments utilizing Boring #1-S

	Nominal Required Bearing (Kips)	Factored Resistance Available (Kips)	Estimated Pile Length (Ft.)
Metal Shell 12"Φ w/.25" walls			
	61	33	21
	67	37	24
	72	40	26
	80	44	29
	88	48	31
	102	56	34
	115	63	36
	121	66	39
	126	70	42
	130	72	44
	134	74	47
	154	85	49
	156	86	50
	157	86	51
	158	87	52
	159	87	53
	160	88	54
	161	89	55
Metal Shell 14"Φ w/.25" walls			
	56	31	16
	65	36	19
	72	40	21
	79	44	24
	85	47	26
	95	52	29
	104	57	31
	122	67	34
	136	75	36
	142	78	39
	148	82	42
	153	84	44
	157	86	47
	184	101	49
	185	102	50
	187	103	51
	188	103	52
	189	104	53
	190	105	54
	192	105	55
Metal Shell 14"Φ w/.312" walls			
	56	31	16
	65	36	19
	72	40	21
	79	44	24
	85	47	26
	95	52	29
	104	57	31
	122	67	34
	136	75	36
	142	78	39
	148	82	42
	153	84	44

	Nominal Required Bearing (Kips)	Factored Resistance Available (Kips)	Estimated Pile Length (Ft.)
Steel HP 10 X 42			
	63	34	31
	75	41	34
	83	46	36
	83	46	39
	87	48	42
	89	49	44
	92	50	47
	97	53	49
	97	54	50
	98	54	51
	98	54	52
	98	54	53
	98	54	54
	99	54	55
	155	85	56
	168	92	57
	335	184	59
Steel HP 10 X 57			
	64	35	31
	76	42	34
	85	47	36
	85	47	39
	89	49	42
	91	50	44
	93	51	47
	99	55	49
	99	55	50
	100	55	51
	100	55	52
	100	55	53
	100	55	54
	101	55	55
	162	89	56
	175	96	57
	454	250	60
Steel HP 12 X 53			
	61	34	26
	71	39	29
	77	42	31
	93	51	34
	102	56	39
	106	58	42
	108	59	44
	111	61	47
	118	65	49
	119	65	50
	119	65	51
	119	66	52
	120	66	53
	120	66	54
	120	66	55
	186	102	56

	Nominal Required Bearing (Kips)	Factored Resistance Available (Kips)	Estimated Pile Length (Ft.)
Steel HP 12 X 84			
	64	35	26
	74	40	29
	80	44	31
	97	53	34
	105	58	39
	110	60	42
	112	61	44
	115	63	47
	123	68	49
	123	68	50
	123	68	51
	124	68	52
	124	68	53
	124	68	54
	124	68	55
	204	112	56
	218	120	57
	664	365	61
Steel HP 14 X 73			
	62	34	19
	66	36	21
	72	40	24
	74	41	26
	87	48	29
	94	52	31
	115	63	34
	122	67	39
	127	70	42
	129	71	44
	133	73	47
	142	78	49
	143	79	50
	143	79	51
	143	79	52
	144	79	53
	144	79	54
	144	79	55
	228	125	56
	246	135	57
	578	318	60
Steel HP 14 X 89			
	63	35	19
	67	37	21
	73	40	24
	75	41	26
	88	48	29
	95	52	31
	117	64	34
	123	68	39
	129	71	42
	130	72	44
	134	74	47

157	86	47
184	101	49
185	102	50
187	103	51
188	103	52
189	104	53
190	105	54
192	105	55
Metal Shell 16"Φ w/.312" walls		
54	30	14
66	36	16
76	42	19
84	46	21
92	51	24
98	54	26
110	61	29
121	67	31
142	78	34
159	87	36
163	90	39
171	94	42
175	96	44
181	99	47
215	118	49
216	119	50
218	120	51
219	120	52
221	121	53
222	122	54
223	123	55
Metal Shell 16"Φ w/.375" walls		
54	30	14
66	36	16
76	42	19
84	46	21
92	51	24
98	54	26
110	61	29
121	67	31
142	78	34
159	87	36
163	90	39
171	94	42
175	96	44
181	99	47
215	118	49
216	119	50
218	120	51
219	120	52
221	121	53
222	122	54
223	123	55
Steel HP 8 X 36		
59	32	34
65	36	36
67	37	39
70	39	42
72	40	44
201	111	57
418	230	59
Steel HP 12 X 63		
62	34	26
71	39	29
78	43	31
94	52	34
102	56	39
107	59	42
109	60	44
112	62	47
120	66	49
120	66	50
120	66	51
120	66	52
121	66	53
121	66	54
121	67	55
193	106	56
208	114	57
497	273	60
Steel HP 12 X 74		
63	35	26
73	40	29
79	44	31
96	53	34
104	57	39
108	60	42
110	61	44
113	62	47
121	67	49
121	67	50
122	67	51
122	67	52
122	67	53
123	67	54
123	68	55
199	109	56
214	117	57
589	324	61
144	79	49
144	79	50
145	80	51
145	80	52
145	80	53
146	80	54
146	80	55
237	130	56
254	140	57
705	388	61
Steel HP 14 X 102		
64	35	19
67	37	21
74	41	24
76	42	26
89	49	29
97	53	31
119	65	34
125	69	39
130	72	42
132	73	44
136	75	47
146	80	49
146	80	50
146	81	51
147	81	52
147	81	53
147	81	54
148	81	55
244	134	56
261	143	57
810	445	61
Steel HP 14 X 117		
58	32	16
65	35	19
68	38	21
75	41	24
77	42	26
90	49	29
98	54	31
120	66	34
126	69	39
132	73	42
133	73	44
137	75	47
147	81	49
148	81	50
148	81	51
148	82	52
149	82	53
149	82	54
149	82	55
252	139	56
269	148	57
929	511	62
Precast 14"x 14"		
59	32	14
71	39	16

74	41	47	83	45	19
78	43	49	92	50	21
79	43	50	101	56	24
79	43	51	108	59	26
79	43	52	121	67	29
79	43	53	133	73	31
79	44	54	155	85	34
79	44	55	174	95	36
125	69	56	181	99	39
135	74	57	189	104	42
286	157	59	194	107	44
			200	110	47
			234	129	49
			236	130	50
			238	131	51
			239	132	52
			241	132	53
			242	133	54
			244	134	55

Illinois Department of Transportation

IDOT STATIC METHOD OF ESTIMATING PILE LENGTH

SUBSTRUCTURE==================================== South Abutments
REFERENCE BORING ================================ 2-S and B-1
LRFD or ASD or SEISMIC ============================== LRFD
PILE CUTOFF ELEV. ================================== 412.40 ft
GROUND SURFACE ELEV. AGAINST PILE DURING DRIVING = 410.40 ft
GEOTECHNICAL LOSS TYPE (None, Scour, Liquef., DD) ====== None
BOTTOM ELEV. OF SCOUR, LIQUEF., or DD ================= ft
TOP ELEV. OF LIQUEF. (so layers above apply DD) =============== ft

TOTAL FACTORED SUBSTRUCTURE LOAD =============== 1800 kips
TOTAL LENGTH OF SUBSTRUCTURE (along skew)========== 153.50 ft
NUMBER OF ROWS OF PILES PER SUBSTRUCTURE ======= 1
Approx. Factored Loading Applied per pile at 8 ft. Cts ============ 93.81 KIPS
Approx. Factored Loading Applied per pile at 3 ft. Cts ============ 35.18 KIPS

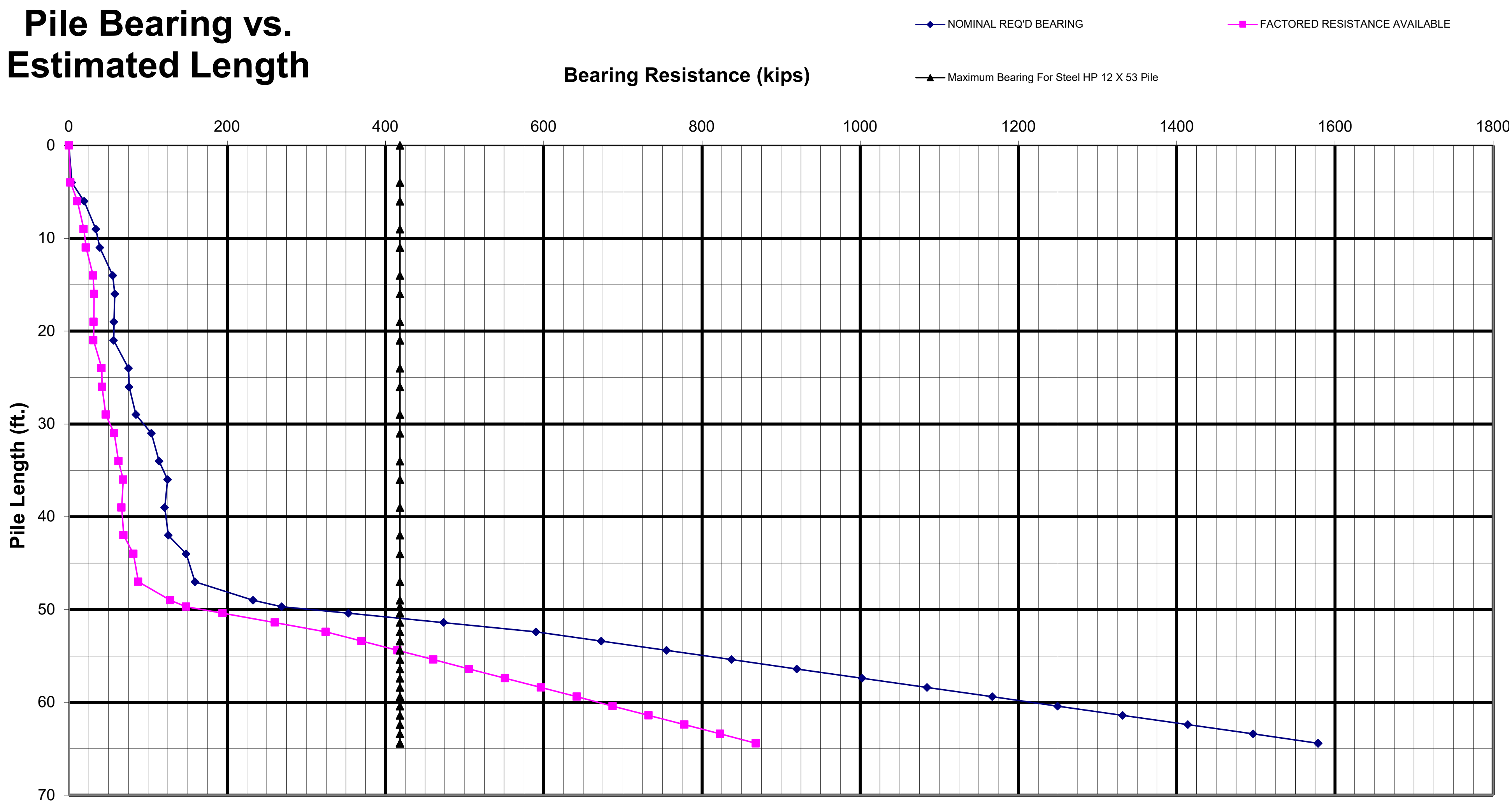
PILE TYPE AND SIZE ============= Steel HP 12 X 53
Plugged Pile Perimeter========================== 3.967 FT. Unplugged Pile Perimeter=============== 5.800 FT.
Plugged Pile End Bearing Area==================== 0.983 SQFT. Unplugged Pile End Bearing Area========= 0.108 SQFT.

MAX. REQUIRED BEARING & RESISTANCE for Selected Pile, Soil Profile, & Losses

Maximum Nominal Req'd Bearing of Pile	Maximum Nominal Req.d Bearing of Boring	Maximum Factored Resistance Available in Boring	Maximum Pile Driveable Length in Boring
418 KIPS	**418** KIPS	**230** KIPS	**51** FT.

BOT. OF LAYER ELEV. (FT.)	LAYER THICK. (FT.)	UNCONF. COMPR. STRENGTH (TSF.)	S.P.T. N VALUE (BLOWS)	GRANULAR OR ROCK LAYER DESCRIPTION	NOMINAL PLUGGED			NOMINAL UNPLUG'D			NOMINAL REQ'D BEARING (KIPS)	FACTORED GEOTECH. LOSS FROM SCOUR or DD (KIPS)	FACTORED GEOTECH. LOSS LOAD FROM DD (KIPS)	FACTORED RESISTANCE AVAILABLE (KIPS)	ESTIMATED PILE LENGTH (FT.)
					SIDE RESIST. (KIPS)	END BRG. RESIST. (KIPS)	TOTAL RESIST. (KIPS)	SIDE RESIST. (KIPS)	END BRG. RESIST. (KIPS)	TOTAL RESIST. (KIPS)					
408.50	1.90	0.10			0.6		25.4	0.9		***3.6***	4	0	0	2	4
406.00	2.50	1.80			10.8	24.8	33.5	15.8	2.7	***19.1***	19	0	0	11	6
403.50	2.50	1.60			10.0	22.0	46.2	14.6	2.4	***34.0***	34	0	0	19	9
401.00	2.50	1.80			10.8	24.8	***39.1***	15.8	2.7	47.8	39	0	0	21	11
398.50	2.50	0.50			3.9	6.9	60.8	5.7	0.8	***55.4***	55	0	0	30	14
396.00	2.50	1.80			10.8	24.8	***57.8***	15.8	2.7	69.7	58	0	0	32	16
393.50	2.50	0.80			5.9	11.0	***56.8***	8.6	1.2	77.5	57	0	0	31	19
391.00	2.50	0.30			2.4	4.1	***56.5***	3.5	0.5	80.7	56	0	0	31	21
388.50	2.50	0.10			0.8	1.4	***75.2***	1.2	0.2	83.9	75	0	0	41	24
386.00	2.50	1.40			9.1	19.3	***76.0***	13.3	2.1	96.2	76	0	0	42	26
383.50	2.50	0.80			5.9	11.0	***84.6***	8.6	1.2	105.1	85	0	0	47	29
381.00	2.50	1.00			7.0	13.8	***104.1***	10.3	1.5	116.8	104	0	0	57	31
378.50	2.50	1.90			11.2	26.2	***113.9***	16.3	2.9	133.0	114	0	0	63	34
376.00	2.50	1.80			10.8	24.8	***124.7***	15.8	2.7	148.7	125	0	0	69	36
373.00	3.00	1.80			12.9	24.8	***121.1***	18.9	2.7	165.8	121	0	0	67	39
370.50	2.50	0.60			4.6	8.3	***125.6***	6.7	0.9	172.5	126	0	0	69	42
368.00	2.50	0.60			4.6	8.3	***148.1***	6.7	0.9	181.1	148	0	0	81	44
365.50	2.50	1.90			11.2	26.2	***159.3***	16.3	2.9	197.5	159	0	0	88	47
363.00	2.50	1.90			11.2	26.2	343.3	16.3	2.9	***232.7***	233	0	0	128	49
362.70	0.30			Sandstone	24.7	199.1	368.0	36.1	21.8	***268.8***	269	0	0	148	49.7
362.00	0.70			Sandstone	57.6	199.1	425.7	84.3	21.8	***353.1***	353	0	0	194	50.4
361.00	1.00			Sandstone	82.4	199.1	508.0	120.4	21.8	***473.6***	~~474~~	~~*0*~~	~~*0*~~	~~*260*~~	~~*51.4*~~
360.00	1.00			Sandstone	82.4	199.1	***590.4***	120.4	21.8	594.0	~~590~~	~~*0*~~	~~*0*~~	~~*325*~~	~~*52.4*~~
359.00	1.00			Sandstone	82.4	199.1	***672.7***	120.4	21.8	714.4	~~673~~	~~*0*~~	~~*0*~~	~~*370*~~	~~*53.4*~~
358.00	1.00			Sandstone	82.4	199.1	***755.1***	120.4	21.8	834.8	~~755~~	~~*0*~~	~~*0*~~	~~*415*~~	~~*54.4*~~
357.00	1.00			Sandstone	82.4	199.1	***837.4***	120.4	21.8	955.2	~~837~~	~~*0*~~	~~*0*~~	~~*461*~~	~~*55.4*~~
356.00	1.00			Sandstone	82.4	199.1	***919.8***	120.4	21.8	1075.7	~~920~~	~~*0*~~	~~*0*~~	~~*506*~~	~~*56.4*~~
355.00	1.00			Sandstone	82.4	199.1	***1002.2***	120.4	21.8	1196.1	~~1002~~	~~*0*~~	~~*0*~~	~~*551*~~	~~*57.4*~~
354.00	1.00			Sandstone	82.4	199.1	***1084.5***	120.4	21.8	1316.5	~~1085~~	~~*0*~~	~~*0*~~	~~*596*~~	~~*58.4*~~
353.00	1.00			Sandstone	82.4	199.1	***1166.9***	120.4	21.8	1436.9	~~1167~~	~~*0*~~	~~*0*~~	~~*642*~~	~~*59.4*~~
352.00	1.00			Sandstone	82.4	199.1	***1249.2***	120.4	21.8	1557.3	~~1249~~	~~*0*~~	~~*0*~~	~~*687*~~	~~*60.4*~~
351.00	1.00			Sandstone	82.4	199.1	***1331.6***	120.4	21.8	1677.7	~~1332~~	~~*0*~~	~~*0*~~	~~*732*~~	~~*61.4*~~
350.00	1.00			Sandstone	82.4	199.1	***1413.9***	120.4	21.8	1798.2	~~1414~~	~~*0*~~	~~*0*~~	~~*778*~~	~~*62.4*~~
349.00	1.00			Sandstone	82.4	199.1	***1496.3***	120.4	21.8	1918.6	~~1496~~	~~*0*~~	~~*0*~~	~~*823*~~	~~*63.4*~~
348.00	1.00			Sandstone	82.4	199.1	***1578.7***	120.4	21.8	2039.0	~~1579~~	~~*0*~~	~~*0*~~	~~*868*~~	~~*64.4*~~
347.00	1.00			Sandstone		199.1			21.8						

Pile Bearing vs. Estimated Length



Pile Design Table for South Abutments utilizing Boring #2-S and B-1

	Nominal Required Bearing (Kips)	Factored Resistance Available (Kips)	Estimated Pile Length (Ft.)
Metal Shell 12"Φ w/.25" walls			
	60	33	14
	65	36	16
	68	37	19
	69	38	21
	81	45	24
	87	48	26
	96	53	29
	113	62	31
	126	69	34
	139	77	36
	145	80	39
	151	83	42
	168	92	44
	181	100	47
Metal Shell 14"Φ w/.25" walls			
	52	29	11
	73	40	14
	77	42	16
	80	44	19
	81	44	21
	97	54	24
	103	57	26
	114	63	29
	135	74	31
	150	82	34
	166	91	36
	170	94	39
	177	97	42
	199	109	44
	215	118	47
Metal Shell 14"Φ w/.312" walls			
	52	29	11
	73	40	14
	77	42	16
	80	44	19
	81	44	21
	97	54	24
	103	57	26
	114	63	29
	135	74	31
	150	82	34
	166	91	36
	170	94	39
	177	97	42
	199	109	44
	215	118	47
Metal Shell 16"Φ w/.312" walls			
	61	33	11
	87	48	14
	90	49	16
	92	50	19
	93	51	21

	Nominal Required Bearing (Kips)	Factored Resistance Available (Kips)	Estimated Pile Length (Ft.)
Steel HP 10 X 42			
	62	34	26
	68	38	29
	83	46	31
	91	50	34
	100	55	39
	103	57	42
	120	66	44
	129	71	47
	194	107	49
	335	184	51
Steel HP 10 X 57			
	63	35	26
	70	39	29
	85	47	31
	93	51	34
	102	56	39
	106	58	42
	122	67	44
	132	72	47
	201	111	49
	454	250	52
Steel HP 12 X 53			
	56	31	21
	75	41	24
	76	42	26
	85	47	29
	104	57	31
	114	63	34
	121	67	39
	126	69	42
	148	81	44
	159	88	47
	233	128	49
	418	230	51
Steel HP 12 X 63			
	57	31	21
	76	42	24
	77	42	26
	85	47	29
	105	58	31
	115	63	34
	122	67	39
	127	70	42
	150	82	44
	161	88	47
	240	132	49
	497	273	52
Steel HP 12 X 74			
	58	32	21
	77	42	24
	78	43	26
	87	48	29

	Nominal Required Bearing (Kips)	Factored Resistance Available (Kips)	Estimated Pile Length (Ft.)
Steel HP 12 X 84			
	58	32	21
	78	43	24
	79	43	26
	88	48	29
	108	60	31
	119	65	34
	125	69	39
	130	72	42
	154	85	44
	166	91	47
	251	138	49
	664	365	53
Steel HP 14 X 73			
	48	26	11
	67	37	14
	67	37	21
	92	51	26
	103	57	29
	129	71	31
	140	77	34
	145	80	39
	151	83	42
	181	100	44
	194	107	47
	284	156	49
	578	318	52
Steel HP 14 X 89			
	48	27	11
	68	37	21
	94	51	26
	105	58	29
	131	72	31
	142	78	34
	147	81	39
	152	84	42
	183	101	44
	197	108	47
	292	161	49
	705	388	52
Steel HP 14 X 102			
	49	27	11
	69	38	21
	95	52	26
	106	58	29
	133	73	31
	144	79	34
	149	82	39
	154	85	42
	186	102	44
	199	110	47
	299	164	49
	810	445	53

114	63	24
120	66	26
132	73	29
158	87	31
175	96	34
193	106	36
196	108	39
203	112	42
231	127	44
249	137	47

Metal Shell 16"Φ w/.375" walls

61	33	11
87	48	14
90	49	16
92	50	19
93	51	21
114	63	24
120	66	26
132	73	29
158	87	31
175	96	34
193	106	36
196	108	39
203	112	42
231	127	44
249	137	47

Steel HP 8 X 36

55	30	29
65	36	31
72	40	34
79	44	36
80	44	39
84	46	42
95	52	44
103	56	47
156	86	49
286	157	51

107	59	31
117	64	34
124	68	39
128	71	42
152	83	44
163	90	47
246	135	49
589	324	52

Steel HP 14 X 117

50	27	11
69	38	21
96	53	26
107	59	29
134	74	31
146	80	34
150	83	39
156	86	42
188	104	44
202	111	47
307	169	49
929	511	54

Precast 14"x 14"

45	25	6
66	36	9
67	37	11
93	51	14
98	54	16
101	56	19
103	57	21
124	68	24
132	72	26
145	80	29
172	95	31
191	105	34
211	116	36
217	119	39
225	124	42
253	139	44

Illinois Department of Transportation

IDOT STATIC METHOD OF ESTIMATING PILE LENGTH

SUBSTRUCTURE=================================== Center Piers
REFERENCE BORING ================================ B-3
LRFD or ASD or SEISMIC ============================== LRFD
PILE CUTOFF ELEV. ================================== 412.40 ft
GROUND SURFACE ELEV. AGAINST PILE DURING DRIVING = 385.20 ft
GEOTECHNICAL LOSS TYPE (None, Scour, Liquef., DD) ====== Scour
BOTTOM ELEV. OF SCOUR, LIQUEF., or DD =============== 383.70 ft
TOP ELEV. OF LIQUEF. (so layers above apply DD) =============== ft

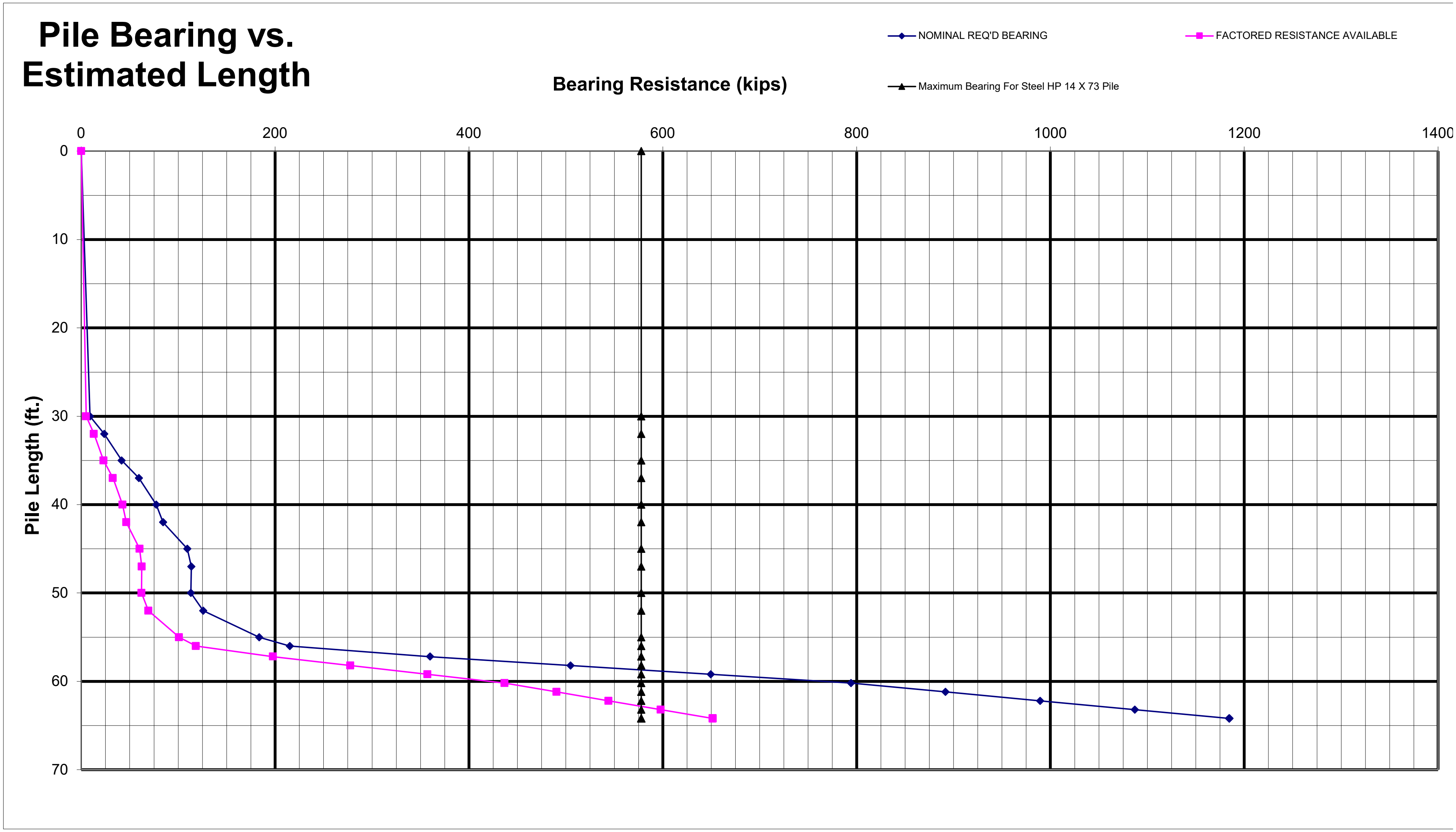
TOTAL FACTORED SUBSTRUCTURE LOAD =============== 3550 kips
TOTAL LENGTH OF SUBSTRUCTURE (along skew)========== 153.50 ft
NUMBER OF ROWS OF PILES PER SUBSTRUCTURE ======= 1
Approx. Factored Loading Applied per pile at 8 ft. Cts ============ 185.02 KIPS
Approx. Factored Loading Applied per pile at 3 ft. Cts ============ 69.38 KIPS

PILE TYPE AND SIZE ============= Steel HP 14 X 73
Plugged Pile Perimeter========================= 4.700 FT. Unplugged Pile Perimeter============== 6.975 FT.
Plugged Pile End Bearing Area=================== 1.379 SQFT. Unplugged Pile End Bearing Area======== 0.149 SQFT.

MAX. REQUIRED BEARING & RESISTANCE for Selected Pile, Soil Profile, & Losses

Maximum Nominal Req'd Bearing of Pile	Maximum Nominal Req.d Bearing of Boring	Maximum Factored Resistance Available in Boring	Maximum Pile Driveable Length in Boring
578 KIPS	**578** KIPS	**318** KIPS	**59** FT.

BOT. OF LAYER ELEV. (FT.)	LAYER THICK. (FT.)	UNCONF. COMPR. STRENGTH (TSF.)	S.P.T. N VALUE (BLOWS)	GRANULAR OR ROCK LAYER DESCRIPTION	NOMINAL PLUGGED			NOMINAL UNPLUG'D			NOMINAL REQ'D BEARING (KIPS)	FACTORED GEOTECH. LOSS FROM SCOUR or DD (KIPS)	FACTORED GEOTECH. LOSS LOAD FROM DD (KIPS)	FACTORED RESISTANCE AVAILABLE (KIPS)	ESTIMATED PILE LENGTH (FT.)
					SIDE RESIST. (KIPS)	END BRG. RESIST. (KIPS)	TOTAL RESIST. (KIPS)	SIDE RESIST. (KIPS)	END BRG. RESIST. (KIPS)	TOTAL RESIST. (KIPS)					
382.70	2.50	0.50			4.6		25.8	6.8		***9.1***	9	0	0	5	30
380.20	2.50	1.10			9.0	21.3	46.4	13.4	2.3	***23.7***	24	0	0	13	32
377.70	2.50	1.70			12.3	32.9	56.8	18.3	3.5	***41.8***	42	0	0	23	35
375.20	2.50	1.60			11.8	30.9	70.6	17.5	3.3	***59.5***	59	0	0	33	37
372.70	2.50	1.70			12.3	32.9	79.0	18.3	3.5	***77.3***	77	0	0	43	40
370.20	2.50	1.50			11.3	29.0	***84.5***	16.8	3.1	93.5	84	0	0	46	42
367.70	2.50	1.20			9.6	23.2	109.6	14.3	2.5	***109.4***	109	0	0	60	45
365.20	2.50	2.00			13.7	38.6	***113.6***	20.3	4.2	128.7	114	0	0	62	47
362.70	2.50	1.50			11.3	29.0	***113.1***	16.8	3.1	144.2	113	0	0	62	50
360.20	2.50		5	Fine Sand	1.0	17.2	***125.9***	1.5	1.9	147.0	126	0	0	69	52
357.70	2.50	1.50			11.3	29.0	321.2	16.8	3.1	***183.6***	184	0	0	101	55
356.20	1.50		62	Clean Coarse Sand	16.5	213.0	403.8	24.5	23.0	***215.1***	215	0	0	118	56
355.20	1.00			Sandstone	97.6	279.1	501.4	144.8	30.1	***360.0***	360	0	0	198	57.2
354.20	1.00			Sandstone	97.6	279.1	599.0	144.8	30.1	***504.8***	505	0	0	278	58.2
353.20	1.00			Sandstone	97.6	279.1	696.6	144.8	30.1	***649.6***	~~650~~	~~*0*~~	~~*0*~~	~~*357*~~	~~*59.2*~~
352.20	1.00			Sandstone	97.6	279.1	***794.1***	144.8	30.1	794.4	~~794~~	~~*0*~~	~~*0*~~	~~*437*~~	~~*60.2*~~
351.20	1.00			Sandstone	97.6	279.1	***891.7***	144.8	30.1	939.2	~~892~~	~~*0*~~	~~*0*~~	~~*490*~~	~~*61.2*~~
350.20	1.00			Sandstone	97.6	279.1	***989.3***	144.8	30.1	1084.0	~~989~~	~~*0*~~	~~*0*~~	~~*544*~~	~~*62.2*~~
349.20	1.00			Sandstone	97.6	279.1	***1086.9***	144.8	30.1	1228.8	~~1087~~	~~*0*~~	~~*0*~~	~~*598*~~	~~*63.2*~~
348.20	1.00			Sandstone	97.6	279.1	***1184.5***	144.8	30.1	1373.7	~~1184~~	~~*0*~~	~~*0*~~	~~*651*~~	~~*64.2*~~
347.70	0.50			Sandstone		279.1			30.1						



Pile Bearing vs. Estimated Length

Pile Design Table for Center Piers utilizing Boring #B-3

	Nominal Required Bearing (Kips)	Factored Resistance Available (Kips)	Estimated Pile Length (Ft.)
Metal Shell 12"Φ w/.25" walls			
	117	64	52
Metal Shell 14"Φ w/.25" walls			
	121	66	47
	139	76	52
Metal Shell 14"Φ w/.312" walls			
	121	66	47
	139	76	52
	552	304	55
Metal Shell 16"Φ w/.312" walls			
	104	57	42
	130	71	45
	141	78	47
	161	89	52
Metal Shell 16"Φ w/.375" walls			
	104	57	42
	130	71	45
	141	78	47
	161	89	52
	699	384	55
Steel HP 8 X 36			
	275	151	58

	Nominal Required Bearing (Kips)	Factored Resistance Available (Kips)	Estimated Pile Length (Ft.)
Steel HP 10 X 42			
	125	69	55
	146	80	56
	335	184	58
Steel HP 10 X 57			
	84	46	52
	130	72	55
	153	84	56
	454	250	60
Steel HP 12 X 53			
	102	56	52
	150	83	55
	176	97	56
	418	230	59
Steel HP 12 X 63			
	104	57	52
	155	85	55
	182	100	56
	497	273	59
Steel HP 12 X 74			
	105	58	52
	159	88	55
	187	103	56
	589	324	60

	Nominal Required Bearing (Kips)	Factored Resistance Available (Kips)	Estimated Pile Length (Ft.)
Steel HP 12 X 84			
	107	59	52
	163	90	55
	192	106	56
	664	365	61
Steel HP 14 X 73			
	126	69	52
	184	101	55
	215	118	56
	578	318	59
Steel HP 14 X 89			
	114	63	50
	128	70	52
	190	104	55
	223	123	56
	705	388	60
Steel HP 14 X 102			
	116	64	50
	129	71	52
	195	107	55
	229	126	56
	810	445	60
Steel HP 14 X 117			
	117	65	50
	131	72	52
	201	110	55
	237	130	56
	929	511	61
Precast 14"x 14"			
	113	62	42
	140	77	45
	154	85	47
	177	97	52

Illinois Department of Transportation

IDOT STATIC METHOD OF ESTIMATING PILE LENGTH

SUBSTRUCTURE=================================== South Abutments
REFERENCE BORING ================================ 2-S and B-1
LRFD or ASD or SEISMIC ============================== SEISMIC
PILE CUTOFF ELEV. ================================== 412.40 ft
GROUND SURFACE ELEV. AGAINST PILE DURING DRIVING = 410.40 ft
GEOTECHNICAL LOSS TYPE (None, Scour, Liquef., DD) ====== Liquef.
BOTTOM ELEV. OF SCOUR, LIQUEF., or DD ============== 388.50 ft
TOP ELEV. OF LIQUEF. (so layers above apply DD) ========= 393.50 ft

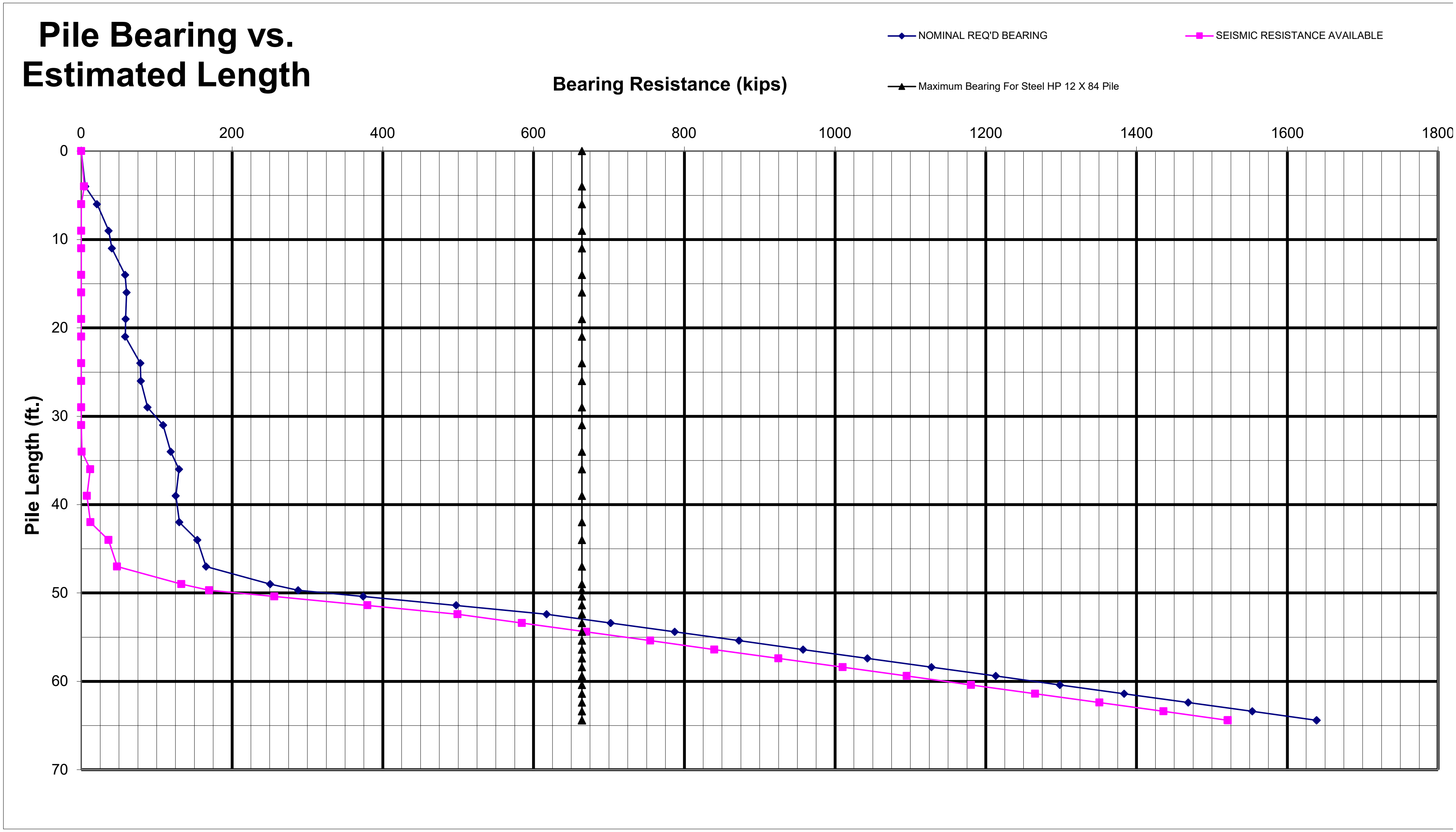
TOTAL SEISMIC SUBSTRUCTURE LOAD ================= 1800 kips
TOTAL LENGTH OF SUBSTRUCTURE (along skew)========== 153.50 ft
NUMBER OF ROWS OF PILES PER SUBSTRUCTURE ======= 1
Approx. Seismic Loading Applied per pile spaced at 8 ft. Cts ======= 93.81 KIPS
Approx. Seismic Loading Applied per pile spaced at 3 ft. Cts ======= 35.18 KIPS

PILE TYPE AND SIZE ============= Steel HP 12 X 84
Plugged Pile Perimeter========================== 4.100 FT.
Unplugged Pile Perimeter=============== 5.942 FT.
Plugged Pile End Bearing Area==================== 1.051 SQFT.
Unplugged Pile End Bearing Area========= 0.171 SQFT.

MAX. REQUIRED BEARING & RESISTANCE for Selected Pile, Soil Profile, & Losses

Maximum Nominal Req'd Bearing of Pile	Maximum Nominal Req.d Bearing of Boring	Maximum Seismic Resistance Available in Boring	Maximum Pile Driveable Length in Boring
664 KIPS	**664** KIPS	**546** KIPS	**53** FT.

BOT. OF LAYER ELEV. (FT.)	LAYER THICK. (FT.)	UNCONF. COMPR. STRENGTH (TSF.)	S.P.T. N VALUE (BLOWS)	GRANULAR OR ROCK LAYER DESCRIPTION	ULTIMATE PLUGGED			ULTIMATE UNPLUGGED			NOMINAL REQ'D BEARING (KIPS)	NOMINAL GEOTECH. LOSS FROM LIQUEF. & DD (KIPS)	FACTORED GEOTECH. LOSS LOAD FROM DD (KIPS)	SEISMIC RESISTANCE AVAILABLE (KIPS)	ESTIMATED PILE LENGTH (FT.)
					SIDE RESIST. (KIPS)	END BRG. RESIST. (KIPS)	TOTAL RESIST. (KIPS)	SIDE RESIST. (KIPS)	END BRG. RESIST. (KIPS)	TOTAL RESIST. (KIPS)					
408.50	1.90	0.10			0.7		27.2	0.9		***5.3***	5	1	1	4	4
406.00	2.50	1.80			11.1	26.5	35.4	16.2	4.3	***20.9***	21	12	13	-4	6
403.50	2.50	1.60			10.3	23.6	48.6	14.9	3.8	***36.3***	36	22	24	-10	9
401.00	2.50	1.80			11.1	26.5	***40.6***	16.2	4.3	49.4	41	33	37	-29	11
398.50	2.50	0.50			4.0	7.4	63.7	5.8	1.2	***58.3***	58	37	41	-20	14
396.00	2.50	1.80			11.1	26.5	***60.2***	16.2	4.3	72.0	60	48	53	-42	16
393.50	2.50	0.80			6.1	11.8	***58.9***	8.8	1.9	79.6	59	54	60	-56	19
391.00	2.50	0.30			2.5	4.4	***58.4***	3.6	0.7	82.7	58	57	60	-59	21
388.50	2.50	0.10			0.9	1.5	***78.4***	1.2	0.2	87.1	78	58	60	-39	24
386.00	2.50	1.40			9.4	20.6	***79.0***	13.6	3.4	99.3	79	58	60	-39	26
383.50	2.50	0.80			6.1	11.8	***88.0***	8.8	1.9	108.5	88	58	60	-30	29
381.00	2.50	1.00			7.3	14.7	***108.5***	10.6	2.4	121.2	108	58	60	-9	31
378.50	2.50	1.90			11.5	28.0	***118.6***	16.7	4.5	137.7	119	58	60	1	34
376.00	2.50	1.80			11.1	26.5	***129.7***	16.2	4.3	153.9	130	58	60	12	36
373.00	3.00	1.80			13.4	26.5	***125.4***	19.4	4.3	170.4	125	58	60	8	39
370.50	2.50	0.60			4.7	8.8	***130.1***	6.8	1.4	177.2	130	58	60	12	42
368.00	2.50	0.60			4.7	8.8	***154.0***	6.8	1.4	187.2	154	58	60	36	44
365.50	2.50	1.90			11.5	28.0	***165.5***	16.7	4.5	203.9	166	58	60	48	47
363.00	2.50	1.90			11.5	28.0	361.8	16.7	4.5	***250.7***	251	58	60	133	49
362.70	0.30			Sandstone	25.5	212.7	387.3	37.0	34.6	***287.7***	288	58	60	170	49.7
362.00	0.70			Sandstone	59.6	212.7	446.9	86.4	34.6	***374.0***	374	58	60	256	50.4
361.00	1.00			Sandstone	85.1	212.7	532.0	123.4	34.6	***497.4***	497	58	60	380	51.4
360.00	1.00			Sandstone	85.1	212.7	***617.2***	123.4	34.6	620.7	617	58	60	499	52.4
359.00	1.00			Sandstone	85.1	212.7	***702.3***	123.4	34.6	744.1	~~*702*~~	~~*58*~~	~~*60*~~	~~*584*~~	~~*53.4*~~
358.00	1.00			Sandstone	85.1	212.7	***787.4***	123.4	34.6	867.5	~~*787*~~	~~*58*~~	~~*60*~~	~~*670*~~	~~*54.4*~~
357.00	1.00			Sandstone	85.1	212.7	***872.5***	123.4	34.6	990.8	~~*873*~~	~~*58*~~	~~*60*~~	~~*755*~~	~~*55.4*~~
356.00	1.00			Sandstone	85.1	212.7	***957.7***	123.4	34.6	1114.2	~~*958*~~	~~*58*~~	~~*60*~~	~~*840*~~	~~*56.4*~~
355.00	1.00			Sandstone	85.1	212.7	***1042.8***	123.4	34.6	1237.5	~~*1043*~~	~~*58*~~	~~*60*~~	~~*925*~~	~~*57.4*~~
354.00	1.00			Sandstone	85.1	212.7	***1127.9***	123.4	34.6	1360.9	~~*1128*~~	~~*58*~~	~~*60*~~	~~*1010*~~	~~*58.4*~~
353.00	1.00			Sandstone	85.1	212.7	***1213.0***	123.4	34.6	1484.3	~~*1213*~~	~~*58*~~	~~*60*~~	~~*1095*~~	~~*59.4*~~
352.00	1.00			Sandstone	85.1	212.7	***1298.2***	123.4	34.6	1607.6	~~*1298*~~	~~*58*~~	~~*60*~~	~~*1180*~~	~~*60.4*~~
351.00	1.00			Sandstone	85.1	212.7	***1383.3***	123.4	34.6	1731.0	~~*1383*~~	~~*58*~~	~~*60*~~	~~*1265*~~	~~*61.4*~~
350.00	1.00			Sandstone	85.1	212.7	***1468.4***	123.4	34.6	1854.4	~~*1468*~~	~~*58*~~	~~*60*~~	~~*1351*~~	~~*62.4*~~
349.00	1.00			Sandstone	85.1	212.7	***1553.5***	123.4	34.6	1977.7	~~*1554*~~	~~*58*~~	~~*60*~~	~~*1436*~~	~~*63.4*~~
348.00	1.00			Sandstone	85.1	212.7	***1638.6***	123.4	34.6	2101.1	~~*1639*~~	~~*58*~~	~~*60*~~	~~*1521*~~	~~*64.4*~~
347.00	1.00			Sandstone		212.7			34.6						


Pile Bearing vs. Estimated Length
Bearing Resistance (kips)
Pile Length (ft.)
NOMINAL REQ'D BEARING
SEISMIC RESISTANCE AVAILABLE
Maximum Bearing For Steel HP 12 X 84 Pile
0
200
400
600
800
1000
1200
1400
1600
1800
0
10
20
30
40
50
60
70

Pile Design Table for South Abutments utilizing Boring #2-S and B-1

	Nominal Required Bearing (Kips)	Seismic Resistance Available (Kips)	Estimated Pile Length (Ft.)
Metal Shell 12"Φ w/.25" walls			
	168	26	44
	181	40	47
Metal Shell 14"Φ w/.25" walls			
	199	34	44
	215	50	47
Metal Shell 14"Φ w/.312" walls			
	199	34	44
	215	50	47
Metal Shell 16"Φ w/.312" walls			
	203	15	42
	231	42	44
	249	61	47
Metal Shell 16"Φ w/.375" walls			
	203	15	42
	231	42	44
	249	61	47
Steel HP 8 X 36			
	103	25	47
	156	79	49
	286	209	51
Steel HP 10 X 42			
	129	34	47
	194	99	49
	335	240	51
Steel HP 10 X 57			
	132	35	47
	201	105	49
	454	357	52
Steel HP 12 X 53			
	148	34	44
	159	45	47
	233	119	49
	418	304	51
Steel HP 12 X 63			
	150	35	44
	161	46	47
	240	125	49
	497	382	52
Steel HP 12 X 74			
	128	12	42
	152	35	44
	163	47	47
	246	129	49
	589	472	52
Steel HP 12 X 84			
	130	12	42
	154	36	44
	166	48	47
	251	133	49
	664	546	53
Steel HP 14 X 73			
	151	16	42
	181	46	44
	194	59	47
	284	149	49
	578	443	52
Steel HP 14 X 89			
	152	16	42
	183	47	44
	197	60	47
	292	156	49
	705	568	52
Steel HP 14 X 102			
	154	16	42
	186	48	44
	199	61	47
	299	161	49
	810	672	53
Steel HP 14 X 117			
	156	16	42
	188	49	44
	202	62	47
	307	168	49
	929	789	54
Precast 14"x 14"			
	225	15	42
	253	43	44

IDOT STATIC METHOD OF ESTIMATING PILE LENGTH

SUBSTRUCTURE==================================== Center Piers
REFERENCE BORING ================================ B-3
LRFD or ASD or SEISMIC ============================== SEISMIC
PILE CUTOFF ELEV. ================================== 412.40 ft
GROUND SURFACE ELEV. AGAINST PILE DURING DRIVING = 385.20 ft
GEOTECHNICAL LOSS TYPE (None, Scour, Liquef., DD) ====== Liquef.
BOTTOM ELEV. OF SCOUR, LIQUEF., or DD =============== 363.00 ft
TOP ELEV. OF LIQUEF. (so layers above apply DD) ========== 368.00 ft

TOTAL SEISMIC SUBSTRUCTURE LOAD ================== 3550 kips
TOTAL LENGTH OF SUBSTRUCTURE (along skew)========== 153.50 ft
NUMBER OF ROWS OF PILES PER SUBSTRUCTURE ======= 1
Approx. Seismic Loading Applied per pile spaced at 8 ft. Cts ======= 185.02 KIPS
Approx. Seismic Loading Applied per pile spaced at 3 ft. Cts ======= 69.38 KIPS

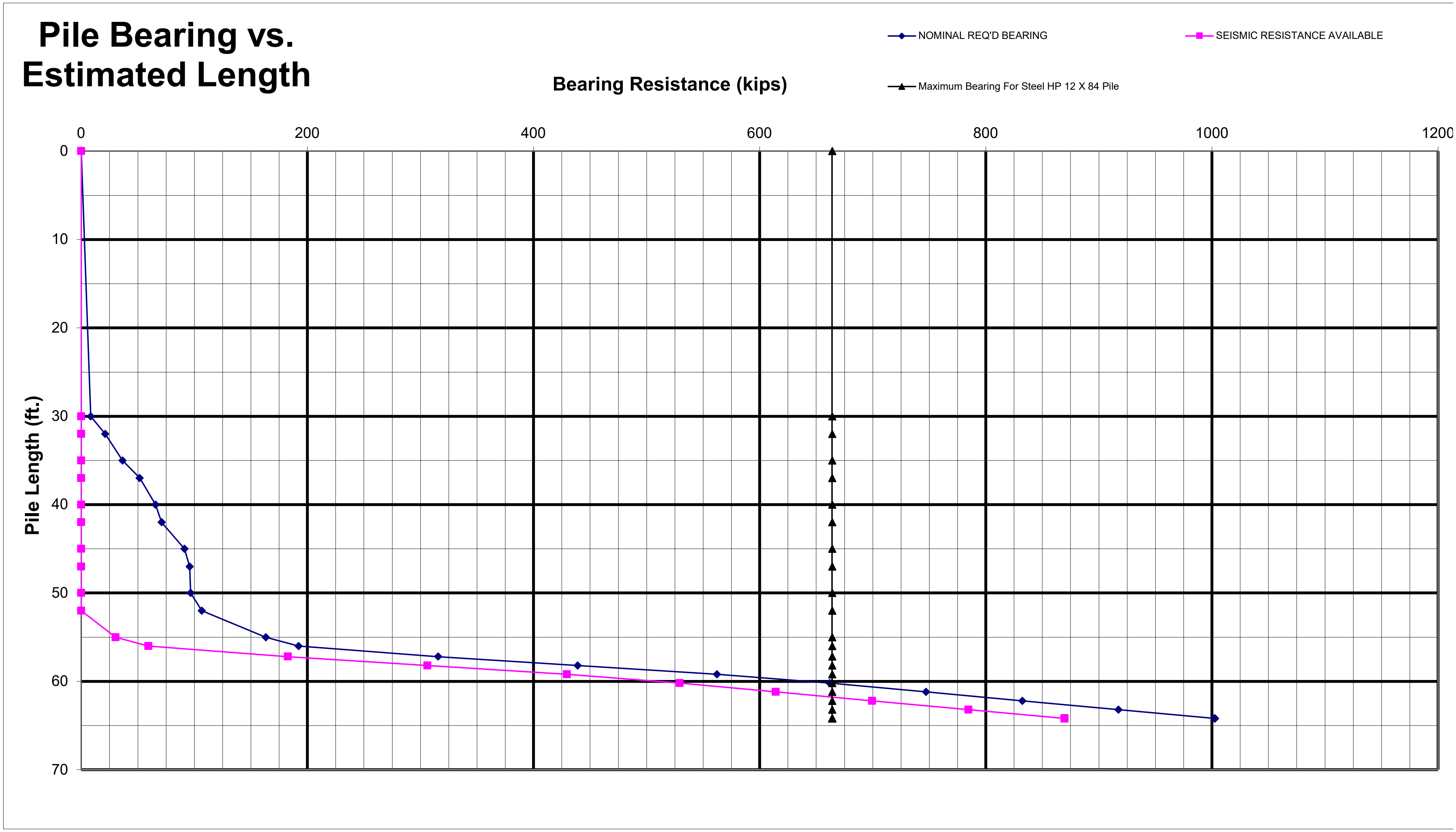
PILE TYPE AND SIZE ============= Steel HP 12 X 84
Plugged Pile Perimeter========================== 4.100 FT. Unplugged Pile Perimeter=============== 5.942 FT.
Plugged Pile End Bearing Area==================== 1.051 SQFT. Unplugged Pile End Bearing Area========= 0.171 SQFT.

MAX. REQUIRED BEARING & RESISTANCE for Selected Pile, Soil Profile, & Losses

Maximum Nominal Req'd Bearing of Pile	Maximum Nominal Req.d Bearing of Boring	Maximum Seismic Resistance Available in Boring	Maximum Pile Driveable Length in Boring
664 KIPS	**662** KIPS	**529** KIPS	**60** FT.

BOT. OF LAYER ELEV. (FT.)	***LAYER THICK. (FT.)***	***UNCONF. COMPR. STRENGTH (TSF.)***	***S.P.T. N VALUE (BLOWS)***	***GRANULAR OR ROCK LAYER DESCRIPTION***	***ULTIMATE PLUGGED***			***ULTIMATE UNPLUGGED***			***NOMINAL REQ'D BEARING (KIPS)***	***NOMINAL GEOTECH. LOSS FROM LIQUEF. & DD (KIPS)***	***FACTORED GEOTECH. LOSS LOAD FROM DD (KIPS)***	***SEISMIC RESISTANCE AVAILABLE (KIPS)***	***ESTIMATED PILE LENGTH (FT.)***
					SIDE RESIST. (KIPS)	***END BRG. RESIST. (KIPS)***	***TOTAL RESIST. (KIPS)***	***SIDE RESIST. (KIPS)***	***END BRG. RESIST. (KIPS)***	***TOTAL RESIST. (KIPS)***					
382.70	2.50	0.50			4.0		20.2	5.8		***8.4***	8	4	4	0	30
380.20	2.50	1.10			7.9	16.2	36.9	11.4	2.6	***21.2***	21	12	13	-4	32
377.70	2.50	1.70			10.7	25.0	46.1	15.6	4.1	***36.6***	37	23	25	-11	35
375.20	2.50	1.60			10.3	23.6	57.9	14.9	3.8	***51.7***	52	33	36	-17	37
372.70	2.50	1.70			10.7	25.0	***65.7***	15.6	4.1	66.8	66	44	48	-26	40
370.20	2.50	1.50			9.9	22.1	***71.1***	14.3	3.6	80.4	71	53	59	-41	42
367.70	2.50	1.20			8.4	17.7	***91.3***	12.2	2.9	94.5	91	62	59	-30	45
365.20	2.50	2.00			11.9	29.4	***95.9***	17.3	4.8	110.6	96	74	59	-37	47
362.70	2.50	1.50			9.9	22.1	***96.8***	14.3	3.6	123.4	97	74	59	-36	50
360.20	2.50		5	Fine Sand	0.9	13.1	***106.6***	1.3	2.1	126.1	107	74	59	-26	52
357.70	2.50	1.50			9.9	22.1	256.7	14.3	3.6	***163.2***	163	74	59	30	55
356.20	1.50		62	Clean Coarse Sand	14.4	162.3	321.5	20.8	26.4	***192.2***	192	74	59	59	56
355.20	1.00			Sandstone	85.1	212.7	406.6	123.4	34.6	***315.6***	316	74	59	183	57.2
354.20	1.00			Sandstone	85.1	212.7	491.7	123.4	34.6	***438.9***	439	74	59	306	58.2
353.20	1.00			Sandstone	85.1	212.7	576.8	123.4	34.6	***562.3***	562	74	59	430	59.2
352.20	1.00			Sandstone	85.1	212.7	***662.0***	123.4	34.6	685.7	662	74	59	529	60.2
351.20	1.00			Sandstone	85.1	212.7	***747.1***	123.4	34.6	809.0	~~747~~	~~74~~	~~59~~	~~614~~	~~61.2~~
350.20	1.00			Sandstone	85.1	212.7	***832.2***	123.4	34.6	932.4	~~832~~	~~74~~	~~59~~	~~699~~	~~62.2~~
349.20	1.00			Sandstone	85.1	212.7	***917.3***	123.4	34.6	1055.7	~~917~~	~~74~~	~~59~~	~~785~~	~~63.2~~
348.20	1.00			Sandstone	85.1	212.7	***1002.4***	123.4	34.6	1179.1	~~1002~~	~~74~~	~~59~~	~~870~~	~~64.2~~
347.70	0.50			Sandstone		212.7			34.6						

Pile Bearing vs. Estimated Length



Pile Design Table for Center Piers utilizing Boring #B-3

	Nominal Required Bearing (Kips)	Seismic Resistance Available (Kips)	Estimated Pile Length (Ft.)
Metal Shell 12"Φ w/.25" walls			
	117	-43	52
Metal Shell 14"Φ w/.25" walls			
	139	-47	52
Metal Shell 14"Φ w/.312" walls			
	139	-47	52
	552	366	55
Metal Shell 16"Φ w/.312" walls			
	161	-51	52
Metal Shell 16"Φ w/.375" walls			
	161	-51	52
	699	487	55
Steel HP 8 X 36			
	275	188	58

	Nominal Required Bearing (Kips)	Seismic Resistance Available (Kips)	Estimated Pile Length (Ft.)
Steel HP 10 X 42			
	247	140	57
Steel HP 10 X 57			
	442	333	59
Steel HP 12 X 53			
	417	288	58
Steel HP 12 X 63			
	426	297	58
Steel HP 12 X 74			
	555	424	59

	Nominal Required Bearing (Kips)	Seismic Resistance Available (Kips)	Estimated Pile Length (Ft.)
Steel HP 12 X 84			
	662	529	60
Steel HP 14 X 73			
	505	353	58
Steel HP 14 X 89			
	190	36	55
	223	69	56
	705	551	60
Steel HP 14 X 102			
	195	39	55
	229	74	56
	810	654	60
Steel HP 14 X 117			
	201	44	55
	237	80	56
	929	772	61
Precast 14"x 14"			
	177	-60	52